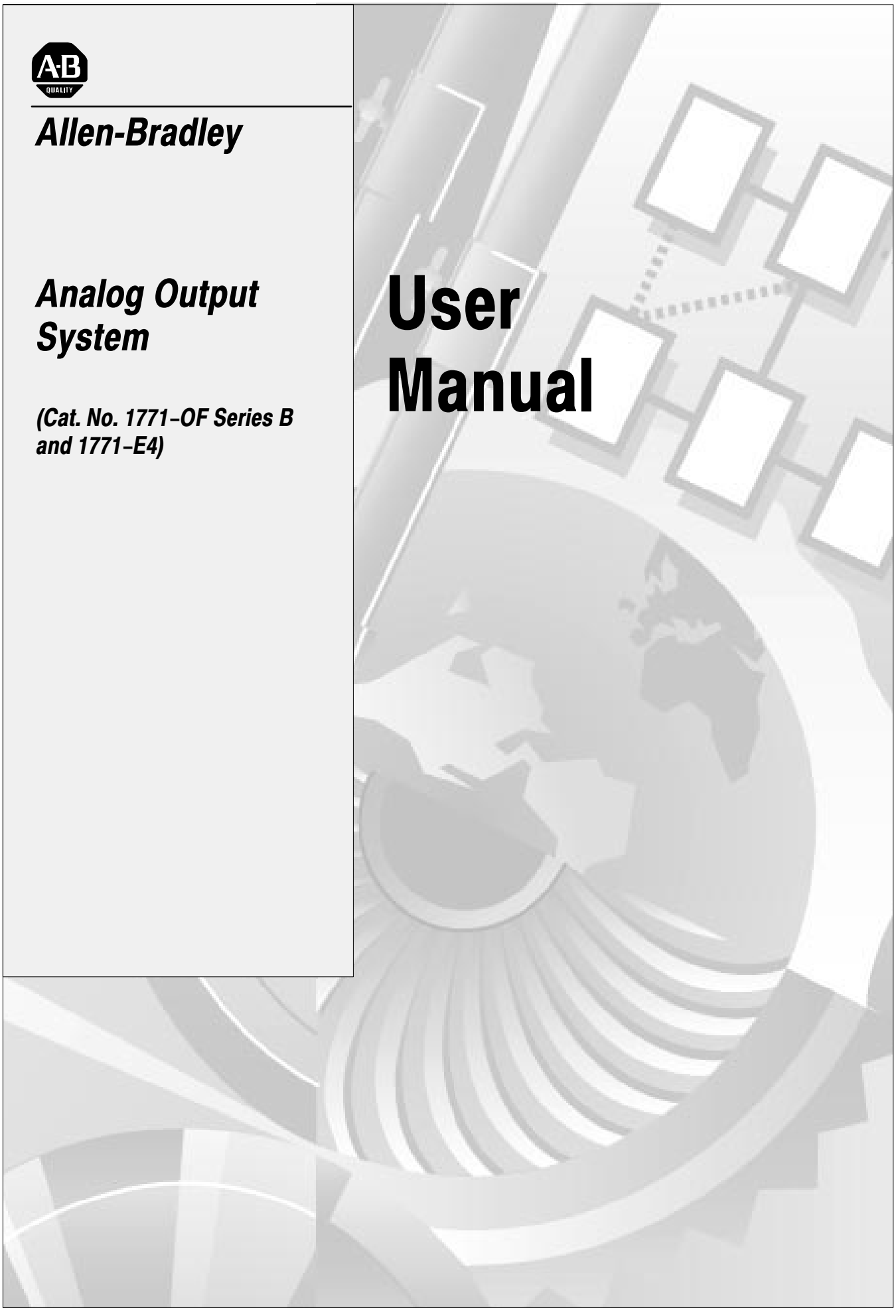

Allen-Bradley

Analog Output System

(Cat. No. 1771–OF Series B and 1771–E4)

User Manual

Important User Information

Because of the variety of uses for this product and because of the differences between solid state products and electromechanical products, those responsible for applying and using this product must satisfy themselves as to the acceptability of each application and use of this product. For more information, refer to publication SGI–1.1 (Safety Guidelines For The Application, Installation and Maintenance of Solid State Control).

The illustrations, charts, and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Allen–Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

No patent liability is assumed by Allen–Bradley Company with respect to use of information, circuits, equipment or software described in this text.

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Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.

WARNING: Tells readers where people may be hurt if procedures are not followed properly.

CAUTION: Tells readers where machinery may be damaged or economic loss can occur if procedures are not followed properly.

Warnings and Cautions:

- Identify a possible trouble spot.
- Tell what causes the trouble.
- Give the result of improper action.
- Tell the reader how to avoid trouble.

Important: We recommend you frequently backup your application programs on appropriate storage medium to avoid possible data loss.

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Chapter 1

Introduction

General

The Analog Output Module (12-bit) Assembly (Cat. No. 1771-OF) Series B and the Analog Output Expander Module Assembly (Cat. No. 1771-E4) are plug-in modules that produce application dependent analog signals at their outputs. These modules form the analog output system. This chapter introduces and describes this system.

Intelligent modules have an on-board processor. The programmable controller also has a processor. The programmable controller processor shall be referred to as the PC processor. The module's processor shall be referred to as such.

The Analog Output Module (Cat. No. 1771-OF, Series B) (hereafter referred to as the analog output module) is a two-slot module which has four single-ended output channels (Figure 1.1). All channels of the output module have the same current or voltage range (+1 to +5V DC, 0 to +10VDC, -10 to +10V DC, 0 to +5V DC, +4 to +20mA, 0 to +20mA and -20 to +20mA). The analog output module may be used alone or with associated analog output expander modules. (Note that the Analog Output Module (12-bit) Assembly (Cat. No. 1771-OF Series A), not covered in this manual, will not accommodate output expanders). Output expander modules provide a method of increasing the output point capacity of a system that is more economical, in cost as well as in module space, than using more analog output modules.

The Analog Output Expander Module (Cat. No. 1771-E4) (hereafter referred to as the output expander module) provides a cost and space-efficient means of increasing the output capacity of a system (Figure 1.2). The output expander module is a single-slot module which has four single-ended output channels. Each channel is individually adjustable without recalibration for any of the following ranges (+1 to +5V DC, 0 to +10V DC, -10 to +10V DC, 0 to +5V DC, +4 to +20mA, 0 to +20mA, -20 to +20mA or -5 to +5V DC).

Block transfer may be used with the following programmable controllers:

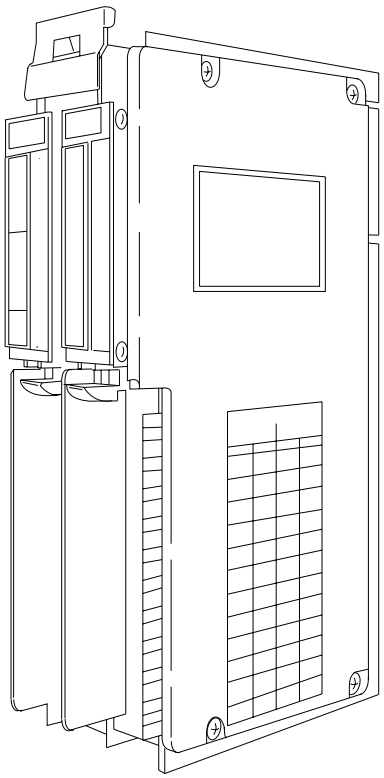
- Mini-PLC-2 (Cat. No. 1772-LN3)
- Mini-PLC-2/15 (Cat. No. 1772-LV)
- PLC-2/20 (Cat. No. 1772-LP1, -LP2)

- PLC-2/30 (Cat. No. 1772-LP3)
- PLC-3 (Cat. No. 1775-L1, -L2)

Single transfer shifts one word each scan. Single transfer may be used with the programmable controllers listed in Table 1.A.

CAUTION: Single transfer must not be used in remote applications except with a PLC controller. Otherwise word integrity of the transferred data will not be maintained.

Figure 1.1
Analog Output Module (12-Bit) Assembly (Cat. No. 1771-OF Series B)



17946

Analog Output Module (1771-OF, Series B)

This intelligent I/O module provides up to four single-ended output channels. Repeatedly, it scans the on-board memory, converts digital words to analog values and outputs them to analog devices. The value word is user selectable. Depending on the mode of transfer selected, the 16 bit word is composed of 12 bits of output signal and 4 channel select bits for single transfer. The four remaining bits are not used in block transfer. The output signal may be selected in 12-bit binary or three-digit BCD. Selection of the binary format provides a resolution of one part in 4096 while selection of the three-digit BCD format provides a resolution of one part in 1000. Module specifications are provided in Chapter 1 under Specifications - Analog Output Module.

Figure 1.2
Analog Output Expander Module Assembly (Cat. No. 1771-E4)

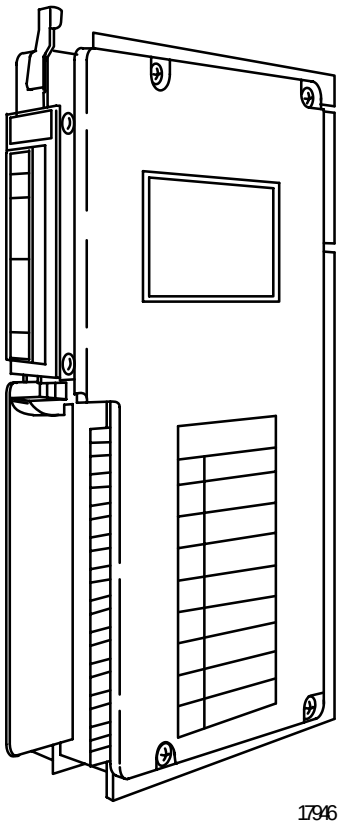


Table 1.A
Processor Interface Capabilities

Processor	Block Transfer	Single Transfer	
		Local (1)	Remote
Mini-PLC-2/15 (Cat. No. 1772-LV)	Yes	Yes	N/A
Mini-PLC-2 (Cat. No. 1772-LN3)	Yes	Yes	N/A
Mini-PLC-2 (Cat No. 1772-LN1, -LN2)	No	Yes	N/A
PLC-2/20 (Cat. No. 1772-LP1, -LP2)	Yes	Yes	No **(2)**
PLC-2/30 (Cat. No. 1772-LP3)	Yes	Yes	No **(2)**
PLC-3 (Cat. No. 1775-L1, -L2)	Yes	N/A	No **(2)**
PLC (Cat. No. 1774-LB2, -LC2)	No	N/A	Yes **(3)**
PLC-2 (Cat. No. 1772-LR)	No	Yes	No **(2)**

(1) I/O modules interfaced with the processor via I/O Adapter Module Cat. No. 1771-AL.

(2) I/O modules interfaced with the processor via a remote I/O Scanner/Distribution Panel and Remote I/O Adapter Module Cat. No. 1771-AS.

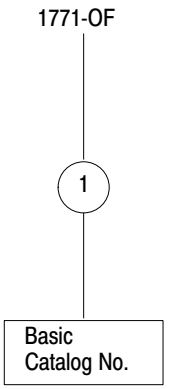
(3) I/O modules interfaced with PLC Processor and Remote I/O Adapter Cat. No. 1771-AR.

The Analog Output Module (12 bit) Assembly (Cat. No. 1771-OF) includes the following:

- One Analog Output Module (12 bit) (Cat. No. 1771-OFC)
- One 12 Terminal Field Wiring Arm (Cat. No. 1771-WB)
- One Product Data (Publication 1771-918)

The analog output module accommodates any one of seven output ranges, each ordered from the factor by specifying a two-digit code suffixed to the catalog number (Table 1.B). Modules can be recalibrated in the field, with appropriate test equipment, to condition them for other than the range ordered.

Table 1.B
Catalog Number Range Codes, 1771-OF



XX
2

Identifying Code		
Mode	Code XX	Range
Voltage	01	+1 to +5V DC
	02	0 to +5V DC
	03	-10 to +10V DC
	04	0 to + 10V DC
Current	05	+4 to + 20 mA
	06	0 to +20 mA
	07	-20 to +20 mA

Analog Output Expander Module (1771-E4)

The analog output expander module provides up to four output points for which it provides signal conditioning. The analog output module communicates digitally with the output expander module via part of the backplane. In this way, the output expander module provides output expansion for the analog output module. Output point capacity may be expanded from a maximum of four points (without expanders) to a maximum of 60 points (with expanders). The analog output module can function with up to 14 expanders. Module specifications are provided in Chapter 1 under Specifications - Output Expander Module.

The Analog Output Expander Assembly (Cat. No. 1771-E4) includes the following:

- One Analog Output Expander (Cat. No 1771-E4C)
- One 12 Terminal Field Wiring Arm (Cat. No. 1771-WB)
- One Product Data (Publication 1771-954)

Applications

This section outlines ranges, expansion capabilities and power requirements of the analog output module and the output expander modules.

Analog Output Module Ranges

The analog output module may be set for any one of the four voltage and three current ranges. Refer to Table 1.C and Table 1.D. All outputs are set to the same range. If you change this range, the output module requires recalibration.

Table 1.C
Output Voltage Ranges

3-Digit BCD Operating Mode			
Nominal Range	**BCD Output Code Range**	**Output Voltage Range**	**Δ V/Bit**
+1 to +5 volts	000-999	+1 to +4.996 volts	4 mV/Bit
0 to +10 volts	000-999	0 to +9.990 volts	10 mV/Bit
-10 to +10 volts	000-999	-10 to +9.980 volts	20 mV/Bit
-5 to +5 volts **(1)**	000-999	-5 to +4.990 volts	10 mv/Bit
0 to +5 volts	000-999	0 to +4.995 volts	5 mV/Bit
12-Bit Binary Operating Mode			
Nominal Range	**Binary Output Code Range**	**Output Voltage Range**	**Δ V/Bit**
+1 to +5 volts	$000\text{-}7777_8$	+1 to +4.9990 volts	0.98 mV/Bit
0 to +10 volts	$000\text{-}7777_8$	0 to +9.9976 volts	2.44 mV/Bit
-10 to +10 volts	$000\text{-}7777_8$	-10 to +9.9951 volts	4.88 mV/Bit
-5 to +5 volts **(1)**	$000\text{-}7777_8$	-5 to +4.9976 volts	2.44 mv/Bit
0 to +5 volts	$000\text{-}7777_8$	0 to +4.9988 volts	1.22 mV/Bit

NOTE: All outputs of the analog output module must operate at the same value. The module must be recalibrated when a range is changed.

Outputs of the output expander module may operate at different values. The module does not require require recalibration when a range is changed..

(1) Output Expander module only.

Expansion

The size of an analog output system with one analog output module as master is dependent upon which programming technique is used. If single transfer is used, up to 16 channels may be configured (one analog output module and three output expander modules). If block transfer is used, up to 60 channels may be configured (one analog output module and 14 output expanders). All output expander modules must be in the same chassis as the analog output module.

Output Expander Module Ranges

The output expander module is totally user selectable to any of the five voltage and three current ranges. Each output may be set to a different range. A change may be made from one range to another without recalibration.

Table 1.D
Output Current Ranges

3-Digit BCD Operating Mode			
Nominal Range	**BCD Output Code Range**	**Output Voltage Range**	**Δ I/Bit**
+4 to +20 mA	000-999	+4 to +19.984 mA	0.016 mA/Bit
0 to +20 mA	000-999	0 to +19.980 mA	0.020 mA/Bit
-20 to +20 mA	000-999	-20 to +19.960 mA	0.040 mA/Bit
12-Bit Binary Operating Mode			
Nominal Range	**BCD Output Code Range**	**Output Voltage Range**	**Δ I/Bit**
+4 to +20 mA	$000\text{-}7777_8$	+4 to +19.9961mA	0.0039 mA/Bit
0 to +20 mA	$000\text{-}7777_8$	0 to +19.9951mA	0.0049 mA/Bit
-20 to +20 mA	$000\text{-}7777_8$	-20 to +19.9902 mA	0.0098 mA/Bit

NOTE:

1. All outputs of the analog output module must operate at the same value. The module must be recalibrated when a range is changed.
2. Outputs of the output expander module may operate at different values. The module does not require require recalibration when a range is changed.

Operating Power

Power for the analog output module and the output expander module is derived from two sources: the I/O chassis power supply and user furnished external power supply.

I/O Chassis Power Supply

The analog output module requires a current of 1.4A and the output expander module requires a current of 165mA from the +5V DC circuit of the power supply. These amounts must be totalled with the current requirements of other modules in the I/O chassis to avoid overloading the supply. One analog output module and 14 output expander modules can be powered in one chassis.

External Power

In addition to I/O chassis power, a separate external power supply is required for the analog output module and the output expander module. Refer to Table 1.E and Table 1.F for the external power requirements. The PLC Remote Power Supply (Cat. No. 1778-P2) or equivalent may be used. The PLC remote power supply provides external power to a maximum of four analog output modules or five output expander modules in the current mode. If the external supply is used to power these modules, it must not be used for I/O rack power.

Table 1.E
Analog Output Module Power Requirements

Specifications	+5 Volts	+15 Volts	-15 Volts
Current (per Analog Output Module) **(1)**	400 mA	250 mA	250 mA
Voltage Tolerance	±5%	1%	1%
Regulations (Type)	Series	Series	Series
Line Regulations (for 10V AC Input Change)	±.02%	±.02%	±.02%
Load Regulation	±.04%	±.02%	±.02%
Ripple	2mV RMS	2mV RMS	2mV RMS
Overvoltage Protection	+7 volts	+18 volts	-18 volts
NOTE: Current requirements in the Current Mode are based on the equation: Current = 170 mA + (20 mA x Number of Current Outputs)			
(1) Current requirements in the Voltage Mode: +15 Volts 170 mA‘ -15 Volts 170 mA			

Table 1.F
Output Expander Module Power Requirements

Specifications	+15 Volts	-15 Volts
Maximum Current 1 (per Analog Output Module) **(1)** Voltage Tolerance Regulations (Type) Line Regulations (for 10V AC Input Change) Load Regulation Ripple (at Swingarm) Overvoltage Protection	200 mA 1% Series ±0.02% ±1.0% 10 mV p-p +18 volts	200 mA 1% Series ±0.02% ±1.0% 10 mV p-p -18 volts
NOTE: Current requirements in the Current Mode are based on the equation: Current = 120 mA + (20 mA x Number of Current Outputs) EXAMPLE: Module selected for 1 Voltage Output and 3 Current Outputs Current = 120 + (20 x 3) = 120 + 60 =	+15 volts 180 mA	-15 Volts 180 mA
(1) Current requirement in the Voltage Mode:	+15 volts 120 mA	-15 volts 120 mA

When the PLC remote power supply is used with an analog output module. Module Power Cable (Cat. No. 1770-CF) may be used to connect power to the field wiring arm. The analog power cables must be ordered separately.

If an equivalent power supply is chosen, the user must also supply all connections.

CAUTION:

1. During initial power-up, the current requirements of the 1771-OF output module's +15V and -15V DC circuits momentarily surge up to 1A. Our Cat. No. 1778-P2 power supply can handle this surge. Any power supply you furnish must be able to handle this surge. Power supplies with foldback current limiting are not recommended.

2. Should either the +15V or -15V DC supply to either the 1771-OF or the 1771-E4 module fail, the output circuits of that module will approach the remaining voltage.

Failure to observe these cautions could result in damage to the module circuitry and unexpected machine operation.

Document Organization

This document describes the installation, operation, programming and calibration necessary to use the analog output module and the output expander module.

Subsequent chapters of this manual are organized as follows:

- Chapter 2 describes module hardware, outlines procedures for preparation, installation, and connection of the module.
- Chapter 3 describes operation and programming necessary for block transfer and single transfer.
- Chapter 4 describes the proper procedures to calibrate an analog output module and an output expander module.
- Chapter 5 outlines troubleshooting procedures.
- Appendix contains sample programs for block transfer and single transfer.

Specifications

This section lists the specifications of the analog output module and the output expander module.

Analog Output Module

Outputs per Module
- 4 Single Ended

Module Location
- Bulletin 1771 I/O Chasis - One Module Group, Two Adjacent Slots

Output Voltage Ranges (Nominal)
- +1 to +5V DC
- 0 to +5V DC
- -10 to +10V DC
- 0 to +10V DC

Output Current Ranges (Nominal)
- +4 to +20 mA
- 0 to +20 mA
- -20 to +20 mA

Digital Resolution
- 3-Digit BCD or 12-Bit Binary

BCD Input from Processor
- 000 to 999 for Any Output Range

Binary Input from Processor
- 0000 to 7777_8 for Any Output Range

BackPlane Power
- 1.4A

Output Overload Protection
- All outputs are protected against short circuit load conditions not to exceed one minuite.

D/A Converter Specifications

Setting Time

- 100μsec Maximum for a Resistive Load

Internal Scan Rate

- .35 msec/Channel without Expanders

- .61 msec/Channel with Output Expanders

Output Impedance
- ≤0.25 ohms for Voltage Outputs Exclusive of Contact Wiring Resistance

- ≥1.5 megohms for Current Outputs

Max Output Current in the Voltage Mode
- 10 mA in Voltage Mode

Max Output Resistance in the Current Mode
- Up to 600 Ohms Load Resistance

Ambient Temperature Rating

- **Operational**
  0°C to +60°C (+32°F to +140°F)

- **Storage**
  -40°C to 85°C (-40°F to +185°F)

Humidity Rating
- 5% to 95% (without Condensation)

Electrical-Optical Isolation
- 1500V RMS (Transient)
- Isolation between the Output Circuit and the Control Logic

Keying
- Left Connector - 2 and 4, 6 and 8
- Right Connector - 4 and 6, 32 and 34

D/A Converter Is Monotonic

Accuracy
Absolute Accuracy Including Linearity, Gain, and Offset (at 25°C):
- ±0.1% of Full Scale
- ±1/2 LSD (BCD Mode)
- ±1/2 LSB (BINARY Mode)

Temperature Coefficient
- ±45 ppm/°C of Full Scale Range

Outputs per Module
- 4 Single Ended

Module Location
- Bulletin 1771 I/O Chasis - One Slot

Output Voltage Ranges (Nominal)
- +1 to +5V DC
- 0 to +5V DC
- -10 to +10V DC
- 0 to +10V DC
- -5 to +5V DC

Output Current Ranges (Nominal)
- +4 to +20 mA
- 0 to +20 mA
- -20 to +20 mA

Digital Resolution (1)
- 3-Digit BCD or 12-Bit Binary

BCD Input from Processor (1)
- 000 to 999 for Any Output Range

Binary Input from Processor (1)
- 0000 to 7777_8 for Any Output Range

BackPlane Power
- 165 mA

Output Overload Protection
- All outputs are protected against short circuit load conditions not to exceed one minuite.

D/A Converter Specifications

Setting Time

- 1 msec , Typical, for a Resistive Load

Output Impedance
- $\leq$0.25 ohms for Voltage Outputs Exclusive of Contact Wiring Resistance

- $\geq$1.5 megohms for Current Outputs

Max Output Current (2)
- 10 mA for Voltage Mode

Max Output Resistance
- Up to 600 Ohms Load Resistance

Ambient Temperature Rating

- **Operational**
  0°C to +60°C (+32°F to +140°F)

- **Storage**
  -40°C to 85°C (-40°F to +185°F)

Humidity Rating
- 5% to 95% (without Condensation)

Electrical-Optical Isolation
- 1500V RMS (Transient)
- Isolation between the Output Circuit and the Control Logic

Keying
- **8 and 10, 28, and 30**

D/A Converter Is Monotonic

Accuracy
Absolute Accuracy Including Linearity, Gain, and Offset (at 25°C):
- $\pm$0.1% of Full Scale
- $\pm$1/2 LSD (BCD Mode)
- $\pm$1/2 LSB (BINARY Mode)

Temperature Coefficient
- $\pm$55 ppm/°C of Full Scale Range

(1) Switch selected at the output mode.

(2) If an individual output is referenced to the -15V DC return, additional compliance is obtained. Maximum load resistance is extended to 1100 ohms.

Chapter 2

Installation

WARNING: Disconnect and lockout all PC processor and I/O chassis power before installing and wiring modules to avoid injury to personnel and damage to equipment.

General

After a configuration of analog output modules or analog output and output expander modules has been planned in accordance with the capabilities defined in Chapter 1 and within the guidelines described in Chapter 2 - Rack Configurations, physical installation can begin. It consists of selecting the options described in Chapter 2 - Conditioning Options 1771-OF and Conditioning Options 1771-E4; inserting the modules into their I/O chassis slots and making connections to the modules' field wiring arms as per Chapter 2 - Connections; and then, when the rack configuration is firm, keying the module slots as specified in Chapter 2 - Keying the Modules. It is recommended that Chapter 2 be read through before beginning work and that all option selections and connections be double checked against Chapter 2, before programming and start-up testing begin.

Rack Configurations

Module grouping limitations are as follows: output expander modules must be housed in the I/O chassis with the associated analog output module. Avoid placing either module close to AC or high voltage DC modules.

Although it is possible to place the module into any I/O module group location, considerations of noise immunity (and power cable lengths) should be kept in mind. Noise can be minimized by grouping analog input and output modules together within an I/O chassis and by not placing high-voltage discrete I/O modules into adjacent module slot locations.

The analog output module requires two adjacent slots in the I/O chassis, and the slots used must be of the same group. It cannot straddle two groups. The output expander requires one slot.

The analog output module can be conditioned to function as master or standalone. When the analog output module is expanded (using associated output expander modules), it must be conditioned as a master. A “master” is here defined as an intelligent I/O module that communicates with associated output expander modules via the backplane. When non-expanded, the analog output module is conditioned as a standalone. No more than two master output modules may reside in one I/O chassis. Also, the number of master and standalone output modules that can be used in a given I/O chassis is restricted by the presence of certain other intelligent I/O modules in the same I/O chassis. The Stepper Positioning Assembly Module (Cat. No. 1771-QA), the Servo Positioning Assembly Module (Cat. No 1771-QC), and the Thermocouple Input Module (cat. no. 1771-IX) are always masters. The Analog Input Module (Cat. No. 1771-IF) may be a master or a standalone. The restrictions exist on an I/O chassis basis. The restrictions do not place limits on the number of modules in an I/O system.

NON-EXPANDED

- The number of standalone analog output modules per I/O chassis is limited only to the number of slot pairs available, provided there are no stepper positioning assembly, servo positioning assembly, analog input module or thermocouple input module masters.
- Up to four stand-alone analog output modules can be used with one master analog input module, master analog output module, or thermocouple input module (always master).
- Up to three standalone analog output modules can be used with two master analog output modules, two master analog input modules, one master analog output module and one master analog input module, or one stepper positioning assembly or one servo positioning assembly masters.
- Up to two standalone analog output modules can be used with one thermocouple input module (always master) and one master analog input module or one master analog output module.

EXPANDED

- There can be no more than two master analog output modules, one master analog output module and one master thermocouple input module, or one master analog input module and one master analog output module.
- A master analog output module is not permitted with a stepper positioning assembly or a servo positioning assembly.

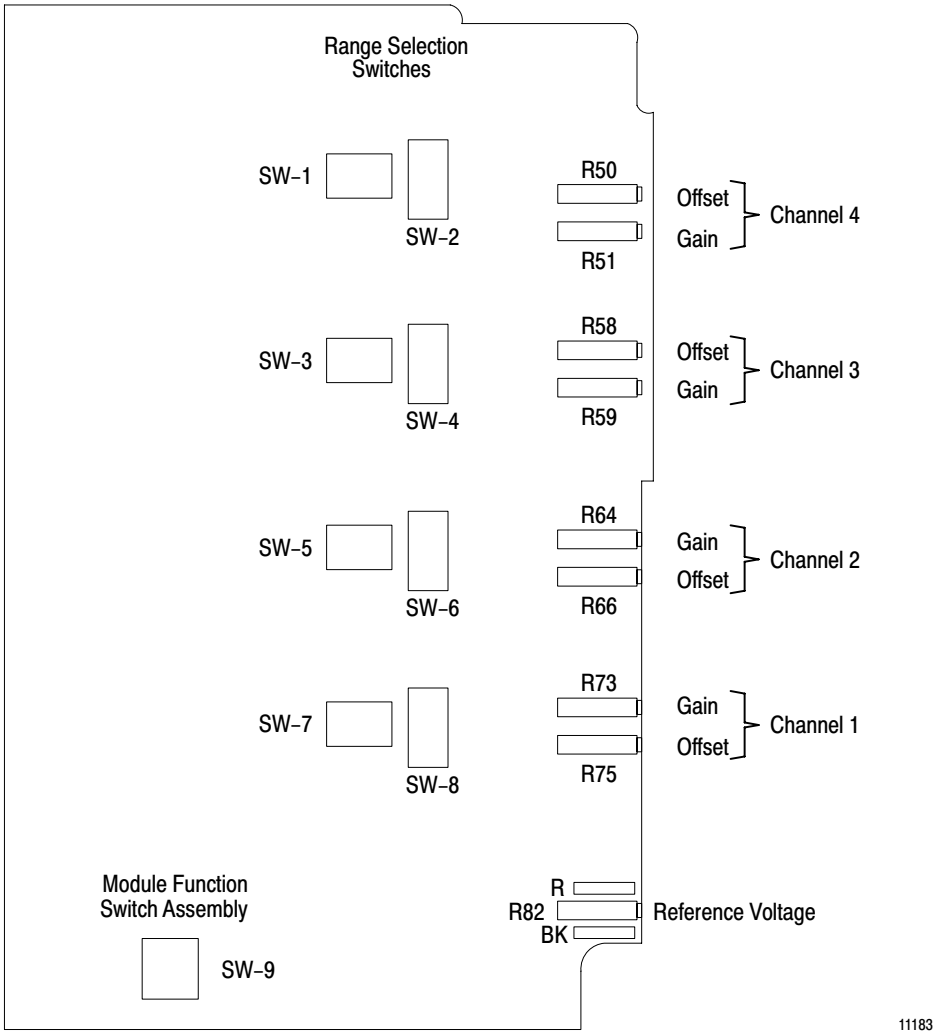
Consult the user’s manual of any other intelligent I/O modules involved for any grouping limitations.

Conditioning Options 1771-OF

Before inserting the analog output module into its I/O chassis slot, you must set the module function and range selection switches (Figure 2.1). These switches determine the mode of data transfer and voltage or current output range.

CAUTION: Modules must not be removed from or inserted into the I/O chassis while system power is ON. Failure to observe this rule may result in damage to module circuitry.

Figure 2.1
Switch and Pot Locations



Module Function Switch SW-9

Switch Assembly SW-9 selects 3-digit BCD or 12-bit binary mode, single or block transfer and master or standalone (Figure 2.2).

Stand Alone/Master Selection (Switches 1 and 4)

If this is the only master module in the chassis, it must be selected as Master 1. If there are two masters in one chassis, one must be Master 1 and the other Master 2. The protocol for transmitting data allows placement of up to two masters in the same bulletin 1771 I/O chassis. A master analog output module accesses its output expander modules using a bus on the backplane. Two masters timeshare this bus. Each master must be designated as Master 1 or Master 2. On the analog output module, this is accomplished by setting Switches 1 and 4 of the module function switch (SW-9) (Figure 2.2 and Table 2.A).

Figure 2.2
Module Function Switch Assembly (SW-9)

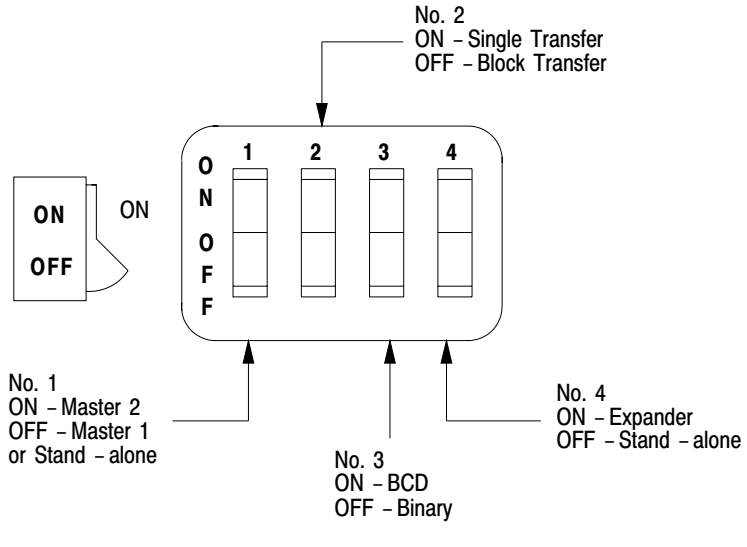


Table 2.A
Stand Alone/Master

Function	Switch 1	Switch 4
Stand Alone	OFF	OFF
Master 1	OFF	ON
Master 2	ON	ON

Block Transfer/Single Transfer

Switch 2 is set for either block transfer or single transfer. Table 1.A identifies which processor may be used with block transfer and which may be used with single transfer local and remote configuration.

BLOCK TRANSFER

Block transfer programming may move up to 60 words (one master and 14 expanders) in a single scan from a designated area in the data table to or from the module. To use block transfer, Switch 2 (Figure 2.2) must be OFF.

SINGE TRANSFER

Single transfer programming may move up to 16 words (one master and three expanders). This type of programming shifts one word each scan from an area designated in the data table to the module. To use single transfer, Switch 2 (Figure 2.2) must be ON.

BCD/Binary

Switch 3 is set as follows for either 3-digit BCD mode or 12-bit binary mode.

3-DIGIT BCD MODE

If the 3-digit BCD mode is selected, Switch 3 of switch assembly SW-9 (Figure 2.2) must be set ON. The processor directly manipulates values in 3-digit BCD to perform mathematical comparisons. This value is output to the module in the range of 000 to 999.

12-BIT BINARY

If the binary mode is selected, Switch 3 of switch assembly SW-9 (Figure 2.2) must be OFF. Certain PC processors directly manipulate values in 3-digit BCD to perform mathematical calculations. The user must construct a binary number from the BCD number. This binary value is output to the module in the range of 0000 to 4095 (0000 to 7777 octal).

Voltage or Current Range Selection

There are two range selection switches for each channel which control range selection for each output on this module. If the range selection switches are changed, the module must be recalibrated.

Conditioning Options 1771-E4

Programming plug conditioning is required prior to inserting the output expanders into the I/O chassis slots and is defined in the following paragraphs. You can access to the programming plug positions (Figure 2.3) by removing the module component-side cover. Store unused programming plugs in the storage area of the circuit board.

The associated analog output module is configured as Master 1 or Master 2. Each output expander module is configured to accommodate a Master 1 or Master 2 output module. Each output expander module is numbered 1 through 14 and configured to correspond to that number. In addition, each output expander module is configured to establish what voltage or current ranges will be output and also whether the outputs will be at maximum or minimum during power-up or reset.

CAUTION: Modules must not be removed from or inserted into the I/O rack while system power is ON. Failure to observe this rule may result in damage to module circuitry.

Analog Output Module Master Selection

An output expander module must be programmed to respond to Master 1 or Master 2 (Table 2.B).

Figure 2.3
Programming Plug and Pot Locations (Rev. 04)

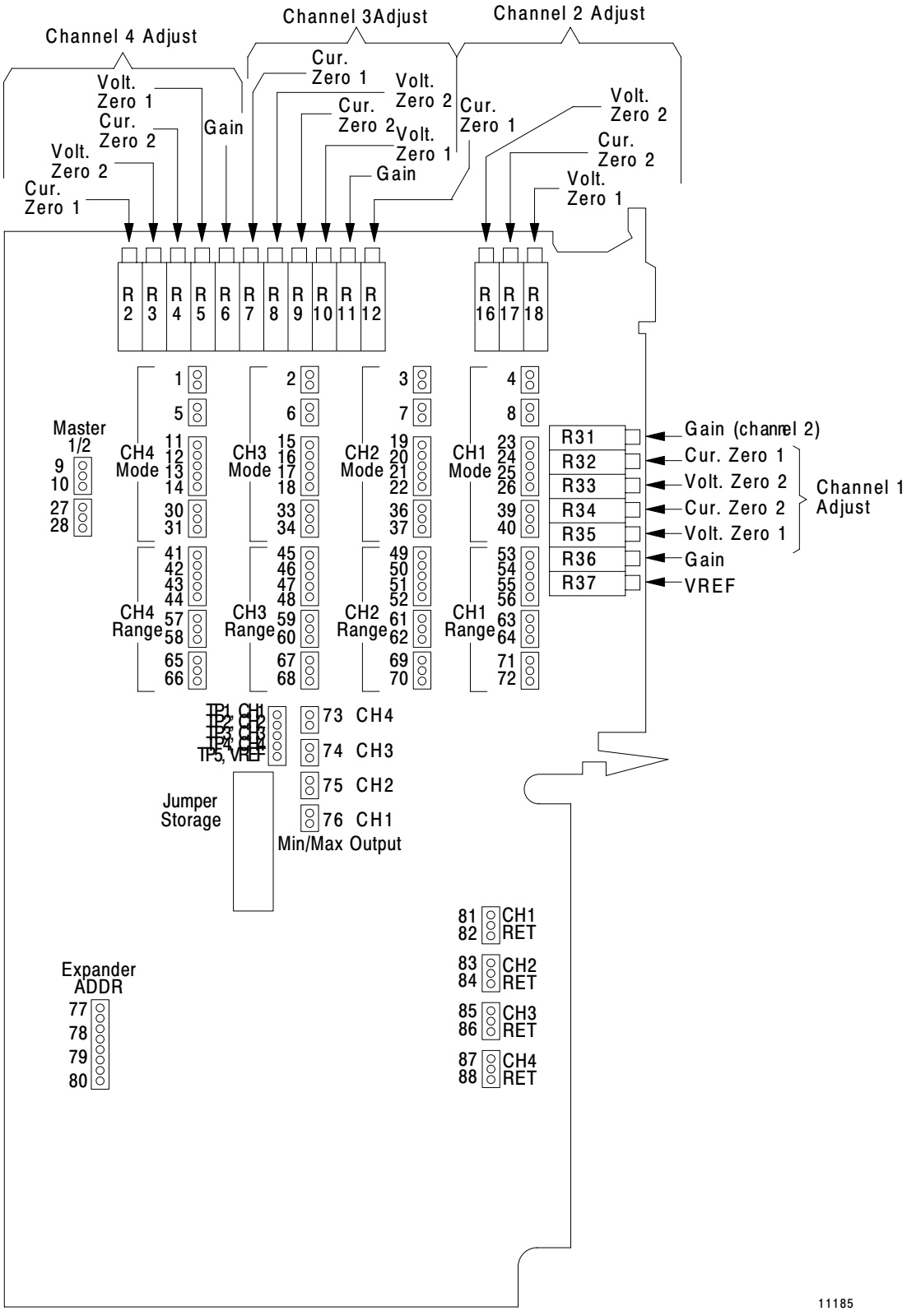


Figure 2.3 - Programming Plug and Pot Locations (Rev. 04) Continued

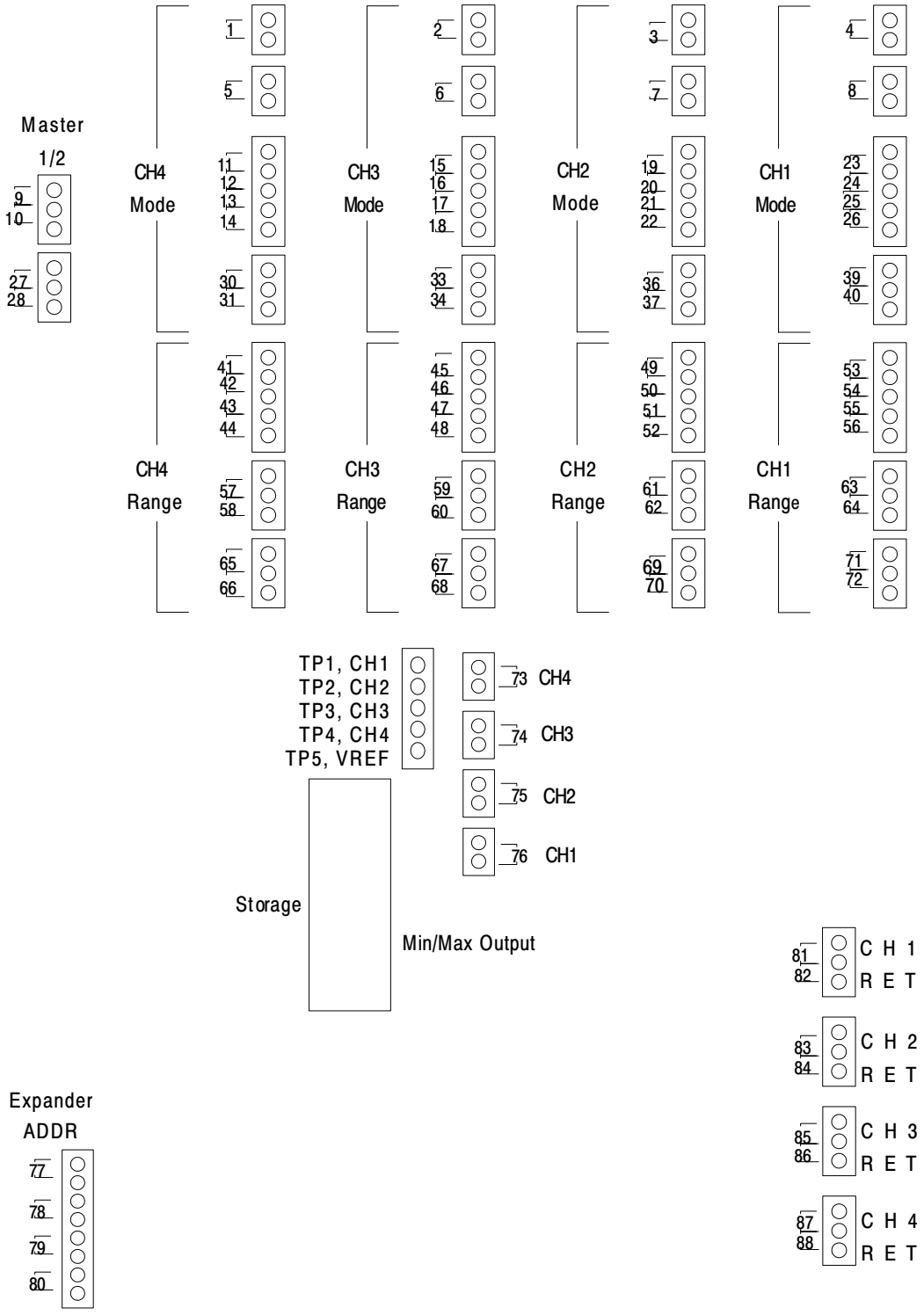


Table 2.B
Master Selection (9, 10, 27,, 28)

Master Selection		
	Insert	**Remove**
Master 1	9.27	10.28
Master 2	10.28	9.27

Output Expander Module Addressing

The output expander modules must be numbered in consecutive order. One cannot skip output expander module numbers. (i.e., Expander 1, Expander 3 but no Expander 2). The maximum number of output expander modules is 14 when using block transfer or 3 when using single transfer (Table 2.C).

Table 2.C
Output Expander Module Addressing (77, 78, 79, 80)

Expander	Plug
1	-80
2	-79
3	-79, 80 **(1)**
4	-78
5	-78, 80
6	-78, 79
7	-78, 79, 80
8	-77
9	-77, 80
10	-77, 79
11	-77, 79, 80
12	-77, 78
13	-77, 78, 80
14	-77, 78, 79
(1)	Only three output expander modules may be used with the output module when single transfer programming is used.

Current or Voltage Mode Selections

Select the voltage range (Table 2.D) or current range (Table 2.E) for the output expander module. Each channel is individually selectable. Insert the programming plugs corresponding to these selections. It is not necessary to recalibrate the output expander module each time a change range is changed.

Table 2.D
Voltage Mode and Range Selection

Channel Number	Voltage Mode	Ranges				
		0 to +5V DC	1 to +5V DC	-5 to +5V DC	0 to +10V DC	-10 to +10V DC
1	23,25,39,81	55,71	55,64,72	53,55,63	54	54, 56, 63
2	19,21,36,83	51,69	51, 62, 70	49, 51,61	50	50, 52, 61
3	15,17,33,85	47,67	47, 60, 68	45, 47, 59	46	46, 48, 59
4	11,13,30,87	43,65	43, 58, 66	41, 43, 57	42	42, 44, 57

Maximum or Minimum Output

Each channel is individually selectable for maximum or minimum output during power-up or reset, which occurs when the PC processor is in the program mode, in the current or voltage range previously selected. Table 2.F identifies the programming plugs. For minimum output, a plug is inserted. The plug is left out for maximum output.

Compliance

Compliance is defined as the maximum allowable load impedance in the current mode. The standard compliance of the output module is 600 ohms. Additional compliance allows a maximum load impedance of 1100 ohms on 4 to 20 mA range only. Additional compliance is obtained by internally referencing the (-Lead) terminal to the -15V DC terminal.

Select standard or additional compliance by inserting plugs according to Table 2.E.

Table 2.E
Current Mode and Range Selection

Channel Number	Current Mode	Ranges			
		0 to +20 mA	-20 to +20 mA	Std. Compliance 4 to +20 mA	Add'l Compliance 4 to +20 mA
1	24, 26, 40	4, 55, 71, 81	4, 53, 55, 63, 81	4, 55, 64, 72, 81	55, 64, 72, 82
2	20, 22, 37	3, 51, 69, 83	3, 49, 51, 61, 83	3, 51, 62, 70, 83	51, 62, 70, 84
3	16, 18, 34	2, 47, 67, 85	2, 45, 47, 59, 85	2, 47, 60, 68, 85	47, 60, 68, 86
4	12, 14, 31	1, 43, 65, 87	1, 41, 43, 57, 87	1, 43, 58, 66, 87	43, 58, 66, 88

Table 2.F
Max./Min. Output Plugs

Channel Number	Plug
1	76
2	75
3	74
4	73
NOTE: Insert plugs for minimum output and remove for maximum output.	

Connections

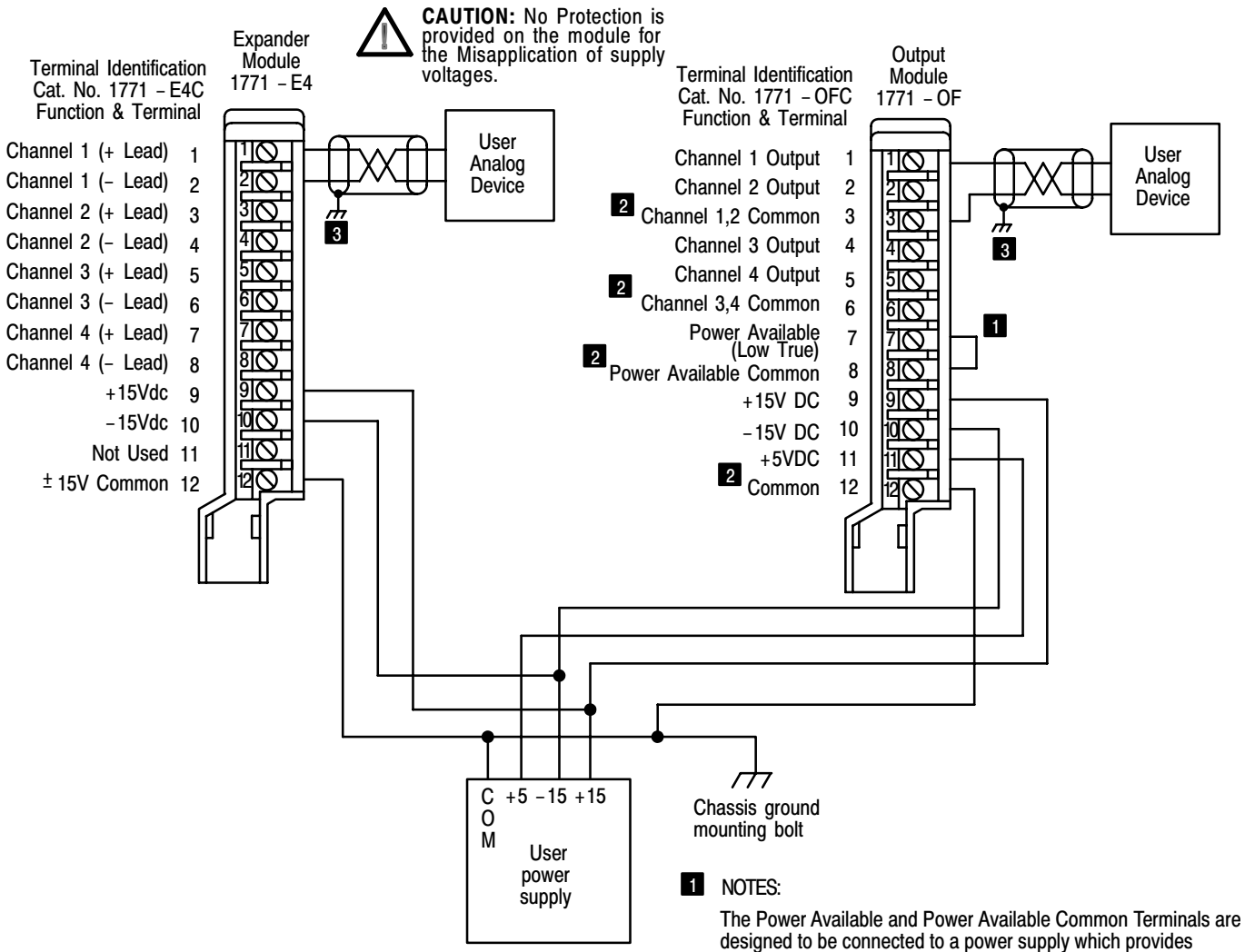
WARNING: To avoid injury to personnel and damage to equipment, disconnect and lockout AC power from the controller and system power supplies before module installation and wiring.

User devices are connected to a field wiring arm (Cat. No. 1771-WB). The field wiring arm pivots on the front of the I/O chassis to connect with the module. Because wiring connections are made at the field wiring arm, an analog output module or an output expander module can be removed from the chassis without the need to disconnect user wiring.

The connection diagram (Figure 2.4) illustrates connections to an analog output module or an output expander module. There are no direct wiring connections between an analog output module and an output expander module. A label on the side cover also identifies terminal connections. Additional space for user labeling is provided on the front of the modules and on the field wiring arms themselves.

CAUTION: Modules must not be removed from or inserted into the I/O rack while system power is ON. Failure to observe this rule may result in damage to module circuitry.

Figure 2.4
Connection Diagram


CAUTION: No Protection is provided on the module for the Misapplication of supply voltages.
Expander Module 1771 – E4
Terminal Identification Cat. No. 1771 – E4C Function & Terminal
Channel 1 (+ Lead) 1
Channel 1 (– Lead) 2
Channel 2 (+ Lead) 3
Channel 2 (– Lead) 4
Channel 3 (+ Lead) 5
Channel 3 (– Lead) 6
Channel 4 (+ Lead) 7
Channel 4 (– Lead) 8
+15Vdc 9
–15Vdc 10
Not Used 11
± 15V Common 12
User Analog Device
Output Module 1771 – OF
Terminal Identification Cat. No. 1771 – OFC Function & Terminal
Channel 1 Output 1
Channel 2 Output 2
2 Channel 1,2 Common 3
Channel 3 Output 4
Channel 4 Output 5
2 Channel 3,4 Common 6
Power Available (Low True) 7
2 Power Available Common 8
+15V DC 9
–15V DC 10
+5VDC 11
2 Common 12
User Analog Device
C O M +5 –15 +15
User power supply
Chassis ground mounting bolt

1 NOTES:

The Power Available and Power Available Common Terminals are designed to be connected to a power supply which provides Power Available Signal. If the power supply does not provide a Power Available Signal, jumper terminals 7 and 8 together. If these terminals are not jumpered the module will not function.

2 All commons are tied together internally.

3 Ground cable to I/O chassis at module end only.

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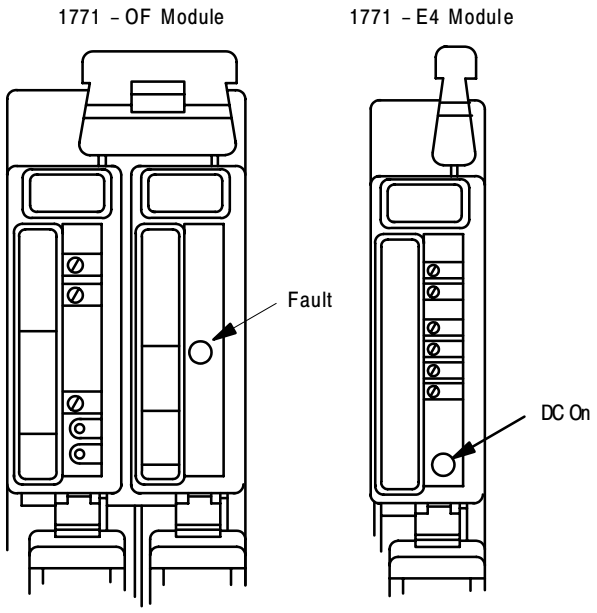
Output Cables for Analog Output Module and Output Expander Module

The modules use shielded cable for signal transmission to the analog devices. Belden 8761, or equivalent, is recommended. This cable consists of a single insulated, twisted-pair conductors, covered along its entire length by a foil shield. The shield reduces the effect of induced noise at any point along the cable. In order to do this, the shield must cover the enclosed pair of wires as completely as possible. Most importantly, the shield must be properly grounded at one end only.

Indicators

There is an LED indicator on the front of each module (Figure 2.5). These indicators are useful for monitoring module activity and troubleshooting.

Figure 2.5
Diagnostic Indicators



The Analog Output Module

The analog output module has a red fault LED which is normally OFF. If the processor is operating in the program or test mode when a fault occurs, the LED flashes alternately ON and OFF. If the processor is operating in the run mode, the LED is ON continuously. During power-up, the LED is ON continuously for the following reasons:

1. Module has failed self diagnostics.

2. Improper programming plug selection when used with an expander.

3. Expander fault.

The Output Expander Module

The output expander module has a green DC ON LED which is ON when -15V and +15V DC are present.

Keying the Modules

CAUTION: The analog output module must be inserted in the I/O chassis so that both halves of the module are in the same I/O module group. Failure to observe this rule will result in faulty module operation and may result in damage to module circuitry.

In initial design stages, the analog output module and the output expander module may be inserted into any slot except the leftmost slot) of the I/O chassis. However, once specified slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly inserted into these slots. Plastic keying bands, shipped with each I/O chassis, provide an easy method to key an I/O chassis slot to accept only one type of module. Use of these keying bands is strongly recommended.

Each I/O module is slotted at its rear edge. The position of keying bands on the backplane connectors must correspond to these slots to allow insertion of the module.

For the analog output module, position the keying bands on the upper backplane connectors between these numbers printed on the backplane.

Left Backplane Connector

- Between 2 and 4
- Between 6 and 8

Right Backplane Connector

- Between 4 and 6
- Between 32 and 34

For the output expander module, position the keying bands on the upper backplane connectors between these numbers printed on the backplane.

- Between 8 and 10
- Between 28 and 30

Chapter 3

Programming

General

This chapter provides information required to program a PC processor to interface with an analog output module with or without output expander modules. Appendices A and B supply sample application programs. Depending upon the PC processor being used, two methods of interface are available: block transfer and single transfer. Table 3.A identifies which processors may be used with block transfer and which may be used with single transfer local and remote configuration.

Table 3.A
Processor Interface Capabilities

Processor	Block Transfer	Single Transfer	
		Local (1)	Remote
Mini-PLC-2/15 (Cat. No. 1772-LV)	Yes	Yes	N/A
Mini-PLC-2 (Cat. No. 1772-LN3)	Yes	Yes	N/A
Mini-PLC-2 (Cat No. 1772-LN1, -LN2)	No	Yes	N/A
PLC-2/20 (Cat. No. 1772-LP1, -LP2)	Yes	Yes	No (2)
PLC-2/30 (Cat. No. 1772-LP3)	Yes	Yes	No (2)
PLC-3 (Cat. No. 1775-L1, -L2)	Yes	N/A	No (2)
PLC (Cat. No. 1774-LB2, -LC2)	No	N/A	Yes (3)
PLC-2 (Cat. No. 1772-LR)	No	Yes	No (2)

(1) I/O modules interfaced with the processor via I/O Adapter Module Cat. No. 1771-AL.

(2) I/O modules interfaced with the processor via a remote I/O Scanner/Distribution Panel and Remote I/O Adapter Module Cat. No. 1771-AS.

(3) I/O modules interfaced with PLC Processor and Remote I/O Adapter Cat. No. 1771-AR.

CAUTION: Single transfer interface must not be used in remote applications except with the PLC Programmable Controller.

The information provided in this chapter supplements the information provided in related manuals. Each programmable controller user's manual or programming manual includes a detailed user's instruction set for its processor and operating procedures for using an industrial terminal, or

other programming panel, to write a user program into memory of the processor.

Operational Overview

The PC processor transfers digital values to the analog output module (Figure 3.1). The analog output module converts the digital values to analog signals which are output to analog devices. The PC processor examines the output module status to detect fault conditions. When an output expander module is added (Figure 3.2), the digital output values for the PC processor are transmitted through the analog output module to the output expander module. All communication between the analog output system and the PC processor occurs through the output module. The output module transmits digital information to the output expander module through the I/O chassis backplane without any direct wiring. The output expander module converts the digital output values to analog signals which are output to analog devices.

Output signal values are periodically transferred from the PC processor to the analog output module. The module stores the data. It continuously scans all output channel in the system to update them with the latest data and performance diagnostics. The PC processor transfers data using either block or single transfer techniques. Block transfer permits up to 60 output signal values to be transferred to the module at one time. Single transfer updates the module one output signal value at a time. Block transfer and single transfer are detailed in Chapter 3 under ”Block Transfer Interface” and ”Single Transfer Interface” respectively.

Figure 3.1
Analog Output Module Operation

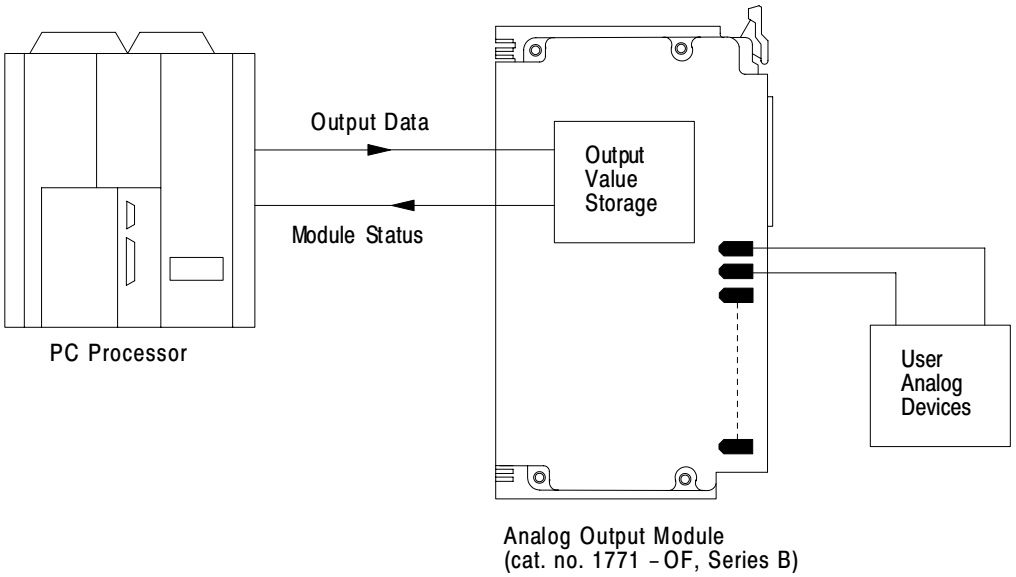
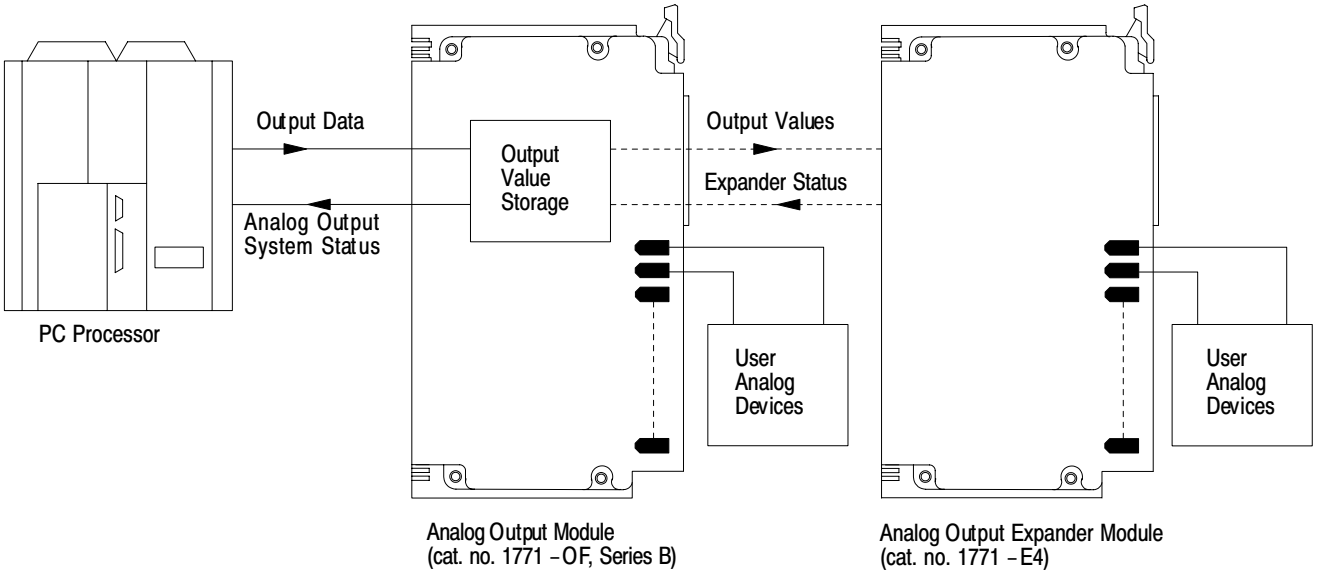


Figure 3.2
Analog Output Module with an Expander



Block Transfer Interface

This is a bi-directional block transfer module. Sixty output words are transferred during a write block transfer. However, only one word is transferred during each read block transfer. If you are unfamiliar with the programming techniques of read and write block transfers, read the explanations in the programming and operations manual for the specific PC processor which you are using.

Write Block Transfer File

Output words are stored in a block file of data table word locations in the PC processor's memory. Each word location in the block file corresponds to a specific output expander or analog output module channel. The configuration of that correspondence is determined by how many channels of the analog output module are used, how many output expander modules are used, and how many output channels of each output expander module are used. These factors dictate how the output expander module programming plug positions are selected. Specific instructions for making these programming plug position selections and connections are given in Chapter 2 under "Conditioning Options 1771-OF" and "Conditioning Options 1771-E4". In summary, these instructions specify the following:

- The output channel are addressed in consecutive order beginning with the analog output module then output expander module 1 and output expander 2. There can be no gap in the order.
- Each output expander is programming plug conditioned to correspond with an output channel.
- When an output expander is selected, you get all four channels. you do not have to wire all four channels. Wiring does not have to be in consecutive order. You can leave a gap in the order.

Table 3.B demonstrates how consecutive locations in the block transfer file correspond to output channel from the conditioning and connecting 60 channel configurations.

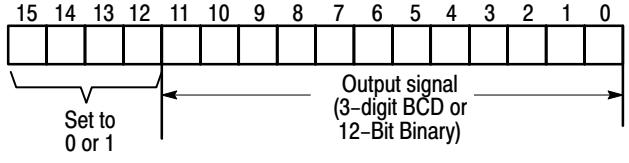
Output Word

The output word (Figure 3.3) for the write block transfer is composed of 16 bits. Bits 13-00 are BCD or binary output signals. Bits 17-14 are not used; set them to either 1 or 0.

Table 3.B
Block File Correspondence Example

Block File Location	Output Channel				
1 2 3 4	1771-OF Channel 1 1771-OF Channel 2 1771-OF Channel 3 1771-OF Channel 4				
	1771-E4 Expander No.	**Channel Number**			
5	1	1	33	8	1
6	1	2	34	8	2
7	1	3	35	8	3
8	1	4	36	8	4
9	2	1	37	9	1
10	2	2	38	9	2
11	2	3	39	9	3
12	2	4	40	9	4
13	3	1	41	10	1
14	3	2	42	10	2
15	3	3	43	10	3
16	3	4	44	10	4
17	4	1	45	11	1
18	4	2	46	11	2
19	4	3	47	11	3
20	4	4	48	11	4
21	5	1	49	12	1
22	5	2	50	12	2
23	5	3	51	12	3
24	5	4	52	12	4
25	6	1	53	13	1
26	6	2	54	13	2
27	6	3	55	13	3
28	6	4	56	13	4
29	7	1	57	14	1
30	7	2	58	14	2
31	7	3	59	14	3
32	7	4	60	14	4

Figure 3.3
Block Transfer Output Word



Block Length

Each block transfer is set for the number of output words to be transferred from the PC processor to the analog output module. The number of words requested by the write block transfer instruction must be a valid number of the module: from 1 to 60. The block length can also be set at the default value. This is particularly useful when programming bi-directional block transfers. A value of 00 is entered for the default value. The maximum length of a write block transfer is 60 words and 1 word for a read block transfer. Enter the default value for read and write block transfers and the module will automatically transfer the exact number of channels the system is configured for.

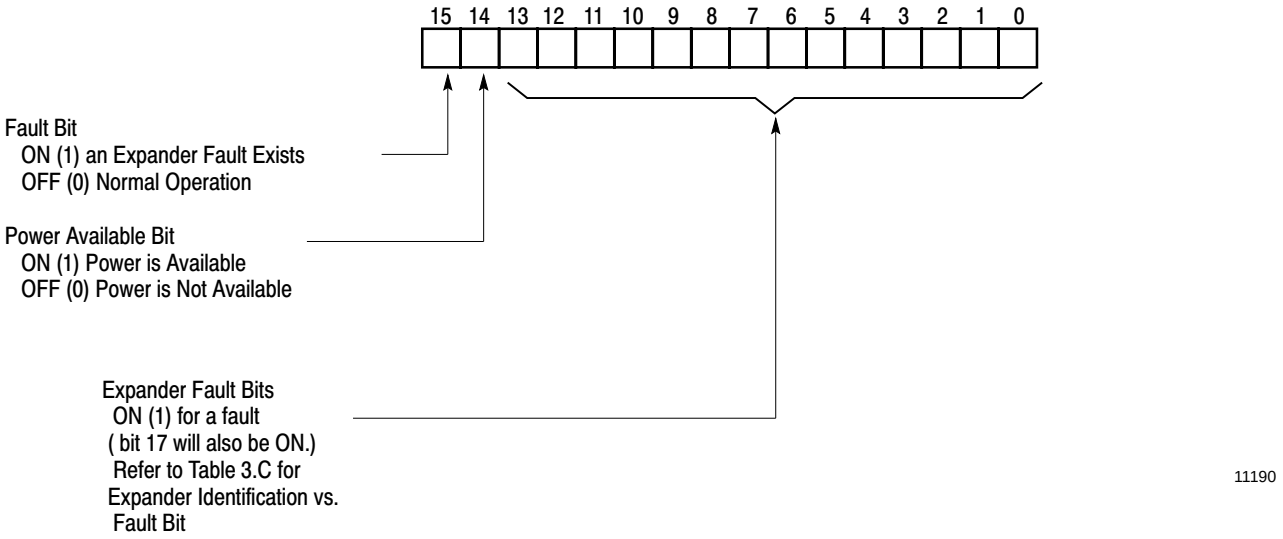
Read Block Transfer File

Read block transfer returns only one diagnostic word. Typically, block transfer is considered a block of data containing many words. However, a read block transfer for the analog output module is only one word long. This word contains all necessary information.

Diagnostic Word

A read block transfer returns one diagnostic word (Figure 3.4). The output expander module fault bits (15-00) set to ON indicate a fault in output expander modules 1-14. Table 3.C correlates output expander module number/bit relationship. The power available bit (16) set to ON indicates power available signal present at the wiring arm. The diagnostic bit (17) is set to ON whenever there is a fault in an output expander module.

Figure 3.4
Block Transfer Diagnostic Word


15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Fault Bit
ON (1) an Expander Fault Exists
OFF (0) Normal Operation
Power Available Bit
ON (1) Power is Available
OFF (0) Power is Not Available
Expander Fault Bits
ON (1) for a fault
(bit 17 will also be ON.)
Refer to Table 3.C for
Expander Identification vs.
Fault Bit
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Block Transfer Update Time

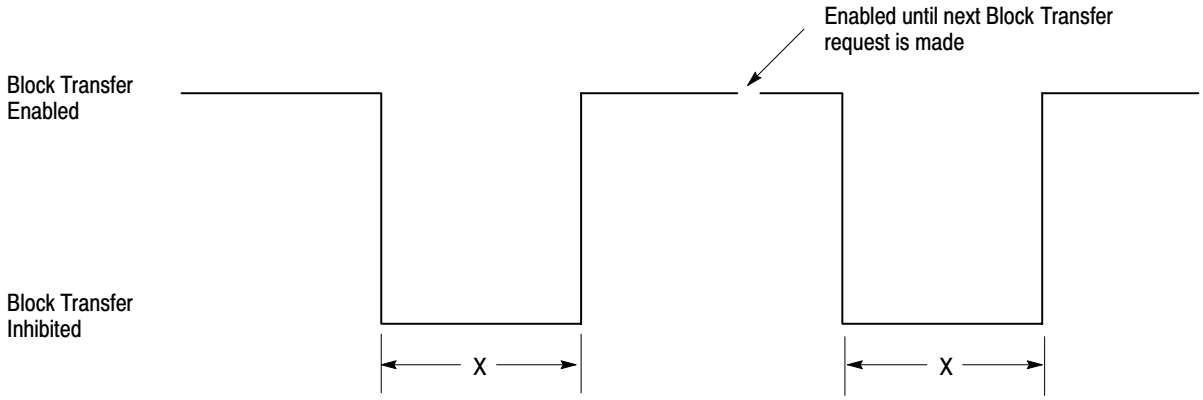
Refer to Figure 3.5. Update time is defined as the time from the end of a block transfer until all output have been updated and the module is available for another block transfer. After each block transfer, the analog output module scans the complete system and updates all channels. Once a block transfer is completed, no further transfers will be accepted until all channels have been updated and diagnostics performed. The update time includes all channels whether data has changed of not. When the analog output module is used without expander modules, the scan rate is .35 msec/channel. When used with expander modules, the scan rate is .61 msec/channel.

The update time also depends upon the number of faulted output expander modules in the chassis. The update time for channels on a faulted output expander module may be twice the normal update time. The update time will increase when a faulted output expander module is detected as the analog output module attempts to re-establish proper communication with the output expander module.

Table 3.C
Expander Identification vs Fault Bit

Bit	Expander No.
00	1
01	2
02	3
03	4
04	5
05	6
06	7
07	8
10	9
11	10
12	11
13	12
14	13
15	14

Figure 3.5
Update Time



X = 0.35 msec/channel for 1771–OF Series B without Output Expanders
X = 0.61 msec/channel with Output Expanders

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Single Transfer Interface

The two sections below (Output Word and Diagnostic Word) describe the single transfer format and the associated channel select word.

CAUTION: Single transfer must not be used in remote applications except with the PLC Programmable Controller. Otherwise, the integrity of the transferred value words will not be maintained. Refer to Table 3.A for definitions of local and remote configurations.

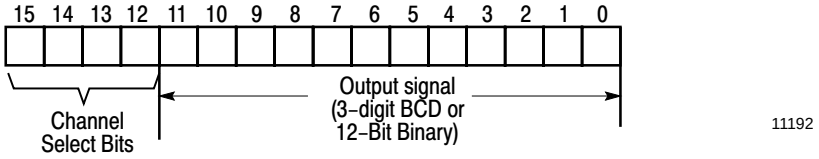
The term single transfer refers to data transfer to one channel each scan. Single transfer takes place in the analog output module essentially the same way as in other I/O modules with the rungs operating in groups of five. That is, the first four rungs select the channel. The fifth rung performs the transfer.

Output Word

The output word for single transfer (Figure 3.6) is composed of 16 bits. Bits 13-00 are BCD or binary output signals. Channel select bits (17-14) are a 4-bit binary code which identifies the output signal with the channel number. Refer to Table 3.D for the correspondence between output expander module/channel select bits and output channels. When there is an output expander module associated with an analog output module and single transfer is used, up to 16 channels may be configured.

The binary coding of the channel select word is used to select both the output expander module and the channel. Refer to Table 3.D for the correspondence between output expander module/channel select bits and output channels.

Figure 3.6
Single Transfer Output Word



Diagnostic Word

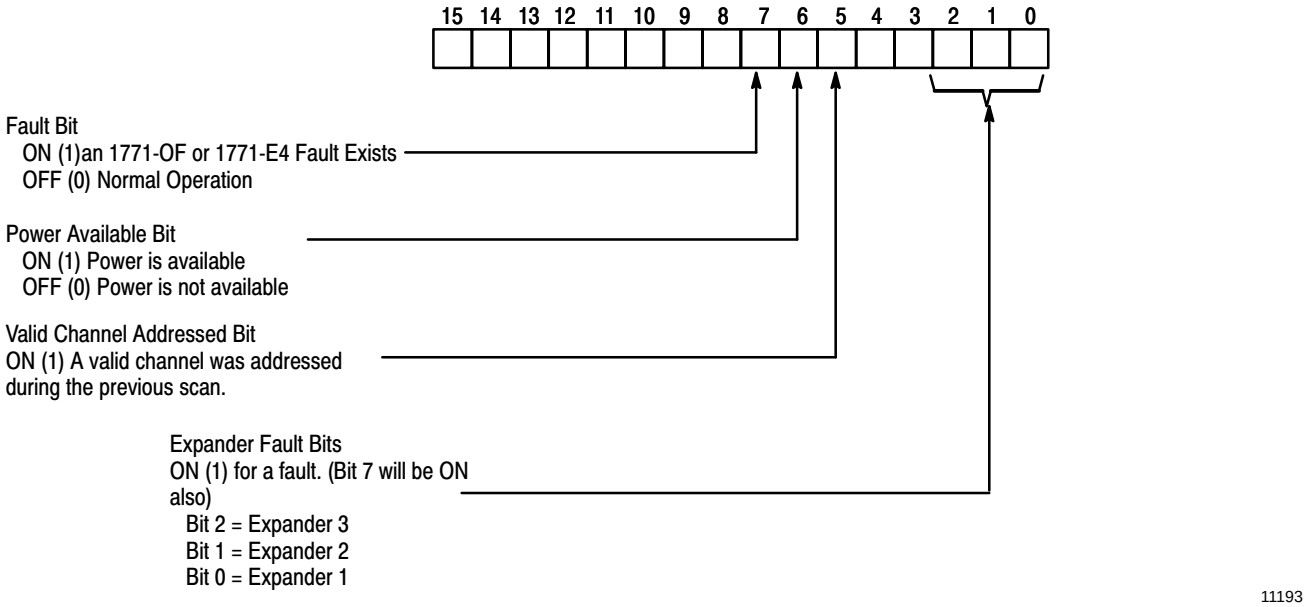
Refer to Figure 3.7. The output expander module fault bits (03-00) set to ON indicate a fault in output expander module 1, 2 or 3. The valid

channel bit (05) set to ON indicates a valid channel was addressed. The power available bit (06) set to ON indicates the power available signal is present at the field wiring arm. The diagnostic bit (07) is set to ON whenever there is a fault in the analog output module or output expander module.

Table 3.D
Single Channel Transfer Select Bit Correspondence

Bit 17	Bit 16	Bit 15	Bit 14	Output Channel	
0	0	0	0	1771-OF Channel 1	
0	0	0	1	1771-OF Channel 2	
0	0	1	0	1771-OF Channel 3	
0	0	1	1	1771-OF Channel 4	
				1771-E4 Expander Number	**Channel Number**
0	1	0	0	1	1
0	1	0	1	1	2
0	1	1	0	1	3
0	1	1	1	1	4
1	0	0	0	2	1
1	0	0	1	2	2
1	0	1	0	2	3
1	0	1	1	2	4
1	1	0	0	3	1
1	1	0	1	3	2
1	1	1	0	3	3
1	1	1	1	3	4

Figure 3.7
Single Transfer Diagnostic Word


15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Fault Bit
ON (1)an 1771-OF or 1771-E4 Fault Exists
OFF (0) Normal Operation
Power Available Bit
ON (1) Power is available
OFF (0) Power is not available
Valid Channel Addressed Bit
ON (1) A valid channel was addressed during the previous scan.
Expander Fault Bits
ON (1) for a fault. (Bit 7 will be ON also)
Bit 2 = Expander 3
Bit 1 = Expander 2
Bit 0 = Expander 1
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Diagnostics

The following paragraphs define the self diagnostics performed by the analog output module and the output expander module at power-up and during normal operation.

Initialization

At power-up, the analog output module checks its internal circuitry.

1. When backplane power is applied to the analog output module, the red FAULT diagnostic LED illuminates. The module executes tests of internal circuitry and checks the power available signal on the field wiring arm. If the analog output module fails these tests, it stops with the FAULT diagnostic LED still illuminated.

2. If no power-up faults are detected, the diagnostic LED is turned OFF.

3. If the analog output module has been designated as a master, a backplane search for the output expander modules programmed to this master is initiated. If a gap is found in the output expander module map (i.e. output expander 1, output expander 3 but no output

expander 2), the diagnostic LED remains illuminated and the appropriate diagnostic bits are turned on in the status word.

The analog output module continuously checks module status while waiting for the first transfer (block or single) request.

Normal Operation

The following checks and responses can occur after the analog output module has passed the initialization check.

1. The analog output module FAULT LED is OFF and the output expander module DC ON LED is ON during normal operation.

2. Module diagnostics consist of testing power available on the field wiring arm and testing each output expander for loss of power or loss of communication. When a fault is detected, the appropriate status bit(s) are turned ON in the status word. The red diagnostic LED on the output will flash ON and OFF if the PC processor is operating in the program or test mode. It will be on (steady) if the PC processor is operating in the run mode.

3. For most faults, the outputs will remain in their last state. See 0Table 5.A in Chapter 5. If the analog output module loses communication with one of the output expander modules, it will continue to scan the other output expander module and will attempt to re-establish communication with the faulted output expander module. The green DC ON LED on the output expander module is ON when 5V DC backplane, +15V DC, and -15V DC are all present.

4. Each channel is continuously updated by the analog output module with the latest information sent from the PC processor. An I/O reset caused by a chassis fault or the PC processor in the program mode will set the analog output module to minimum value and output expander module goes to the program plug selected value (maximum or minimum).

Chapter 4

Calibration

General

Each module is carefully adjusted to provide a high degree of accuracy. Calibration should be checked every 12 months to ensure maintenance of this accuracy.

Allen-Bradley offers the following options:

- return the module to Systems Division for calibration.
- calibrate in your test or development installation.

WARNING: Do not attempt calibration without reading and thoroughly understanding all steps in this procedure. Also, do not attempt to calibrate these modules in an operating system.

Tools and Test Equipment

Table 4.A lists tools and test equipment required for calibration for both modules.

Table 4.A
Test Equipment

Equipment	Description
5 1/2 Digit Digital Voltmeter(DVM)	0.01% Accuracy minimum (A Keithley 191, Fluke 8300A, or equivalent)
Load Resistor (for Current Outputs)	250 ohms, 1/4 watt, ±0.025% Allen-Bradley Systems Part No. 610996-01
Load Resistor (for Current Output)	250 ohm, 1/4 watt, 5% Carbon Composition Resistor
Load Resistor (for Voltage Output)	1000 ohms 1/4 watts, 5% Metal-Film Resistor
Load Resistor (for Voltage Outputs)	1.2K ohms, 1/4 watt, 5 or 10% Carbon Composition Resistor
Sealant	Organic Products P.O. Box 428 Irving, Texas 75060 “Torque Seal”

Equipment	Description
Alignment Tool “Pot Tweeker”	Newark Electronics 500 North Pulaski Road Chicago, IL 60624 Part No. 35616
Program Panel	Optional Industrial Terminal System
Extender Board - Optional	Allen-Bradley (Cat. No. 1771-EX)

The Analog Output Module

You must calibrate the analog output module in an I/O chassis. The module needs to communicate with the processor and industrial terminal. You will perform two general steps. Then, you will calibrate a typical channel, i.e., Channel 1.

- Prepare the analog output module for calibration.
- Adjust the reference voltage.
- Calibrate a typical channel.

PREPARATION

First, prepare the module by setting the module function and range selection switches (Figure 4.1). These switches determine the mode of data transfer and voltage or current output range. The module must be calibrated in the range in which it will be applied. If the range switches are changed, the analog output module must be recalibrated.

1. Turn off the processor and I/O chassis power.

2. Remove the analog output module from the I/O chassis.

3. Remove the four screws and the component-side cover.

4. Set the module function Switch SW-9 (Figure 4.2 and Table 4.B) as follows:

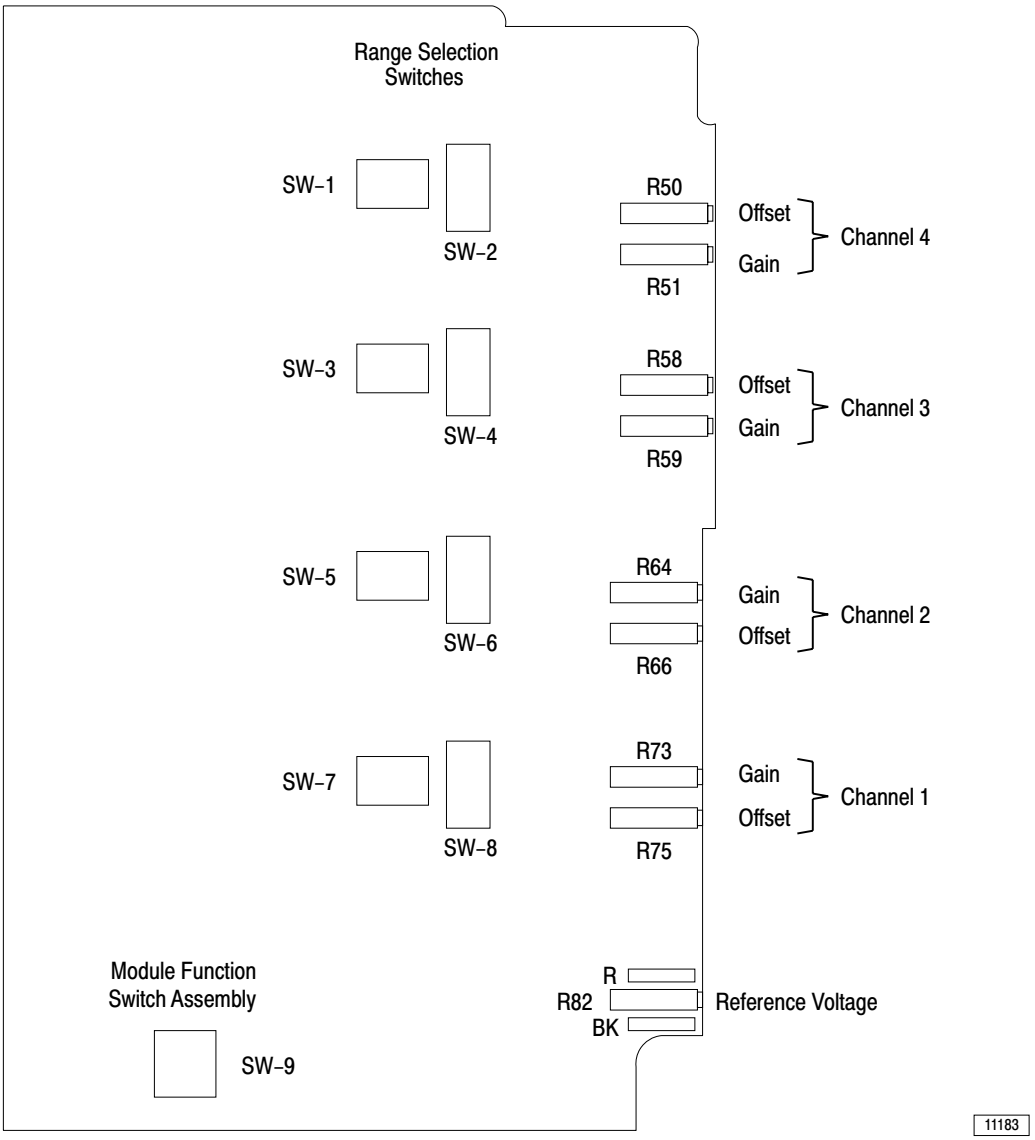
- Switch 1 - OFF (stand alone)
- Switch 2 - ON (single transfer) or OFF (block transfer)
- Switch 3 - ON (BCD) or OFF (binary) - The analog output module must be calibrated in the same mode that will be used. This example uses BCD.
- Switch 4 - OFF (standalone module)

5. There are two range selection switches for each channel (Figure 4.1).

- Switches SW-7 and 8 select Channel 1
- Switches SW-5 and 6 select Channel 2
- Switches SW-3 and 4 select Channel 3
- Switches SW-1 and 2 select Channel 4

Set these switches according to Table 4.C and Table 4.D.

Figure 4.1
Switch and Pot Locations



6. Install the analog output module in the I/O chassis.

7. Install a field wiring arm.

8. Connect the following at the field wiring arm:

- ±15 and +5 volt power supply
- Power available jumper

9. Connect a load resistor (Table 4.A) (250 ohm, l/4 watt, 5% for current or 1.2K ohm for voltage). Refer to Table 4.E for channel test load connections and adjustments.

REFERENCE VOLTAGE ADJUSTMENT

Second, adjust the reference voltage.

1. Connect the DVM between the red (+) and black (-) test points at the bottom of the module (Figure 4.1).

2. Turn on processor, industrial terminal, and I/O chassis power.

3. Adjust R82 (Figure 4.1) to 2.5000V ±0.1 mV.

TYPICAL CHANNEL CALIBRATION PROCEDURE

Third, to calibrate a channel, you must enter a one channel test program (Figure 4.3). The analog output module could be calibrated using either block or single transfer. Figure 4.3 is a single transfer program entered in a PLC-2/30 processor. The same program may be entered in either a PLC or PLC-2 Family processor. The only difference between the two programs will be the address and types of bits. The interpretation of these bits is shown in Table 4.F. It should be left in the processor to calibrate the other three channels.

1. Connect the DVM across the load resistor

2. Enter a program similar to that illustrated in Figure 4.3. Channel 1 output signal value is stored in address 0301. For other channels, change the GET address to reflect the memory location of the channel to be calibrated.

- Channel 2 - 0302
- Channel 3 - 0303
- Channel 4 - 0304

The output channel is designated by setting Bits 17-14 of the the output signal value word. Bits (17-14) are a 4-bit binary code which identifies the channel number (Table 4.G). The bits are actually set in the intermediate words.

Figure 4.2
Module Function Switch Assembly (SW-9)

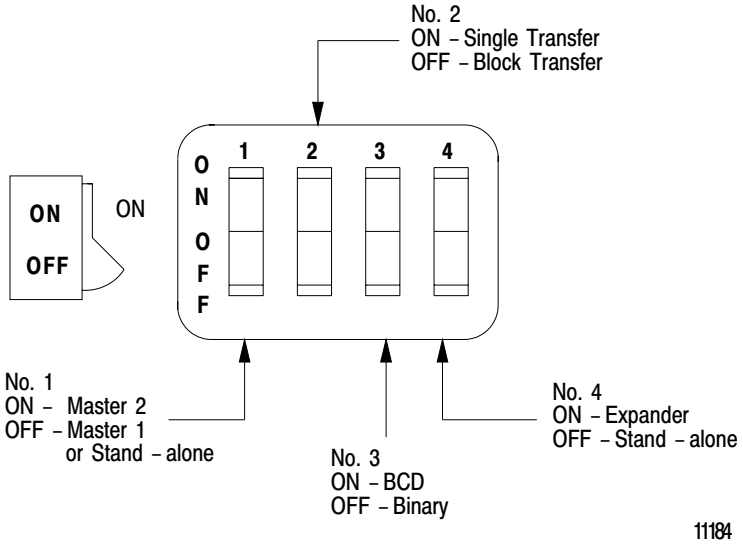


Table 4.B
Stand Alone/Master

Function	Switch 1	Switch 4
Stand Alone	OFF	OFF
Master 1	OFF	ON
Master 2	ON	ON

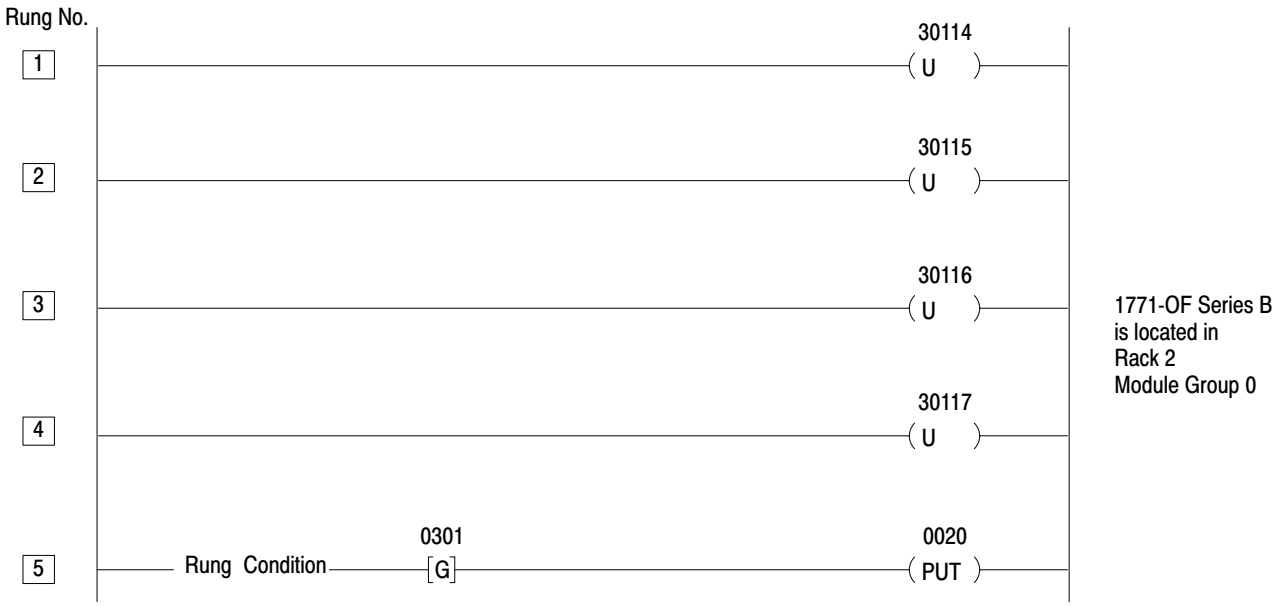
Table 4.C
Settings for Odd Numbered Range Selection Switches

Range	Position				
	1	2	3	4	5
0-5V	ON	OFF	ON	OFF	ON
±10.0V	OFF	ON	OFF	ON	OFF
0-10V	ON	OFF	OFF	OFF	ON
1-5V	ON	OFF	OFF	OFF	ON
4-20 mA	ON	OFF	OFF	OFF	ON
0-20 mA	ON	OFF	ON	OFF	ON
±20 mA	OFF	ON	OFF	OFF	ON

Table 4.D
Settings for Even Numbered Range Selection Switches

Range	Position							
	1	2	3	4	5	6	7	8
0-5V	OFF	OFF	ON	OFF	ON	ON	OFF	OFF
±10.0V	OFF	OFF	ON	OFF	ON	ON	OFF	OFF
0-10V	OFF	OFF	ON	OFF	ON	ON	OFF	OFF
1-5V	ON	OFF	OFF	OFF	ON	ON	OFF	ON
4-20 mA	ON	OFF	OFF	ON	OFF	OFF	ON	ON
0-20 mA	OFF	OFF	ON	ON	OFF	OFF	ON	OFF
±20 mA	OFF	OFF	ON	ON	OFF	OFF	ON	OFF

Figure 4.3
General Example of Channel Select Bits



Channel 1 value is stored in Word 0301.
Channel Select Bits 14, 15, 16, 17 are set to 0 to Select Channel 1.
Rung 5 enabled to transfer Channel 1 to 1771-OF Series B.

Table 4.E
Channel Test Load Connections

Channel	Terminals	Offset Pots	Gain Pots
1	1 and 3	R75	R73
2	2 and 3	R66	R64
3	4 and 6	R58	R59
4	5 and 6	R50	R51

Table 4.F
Output Instructions

Processor	Bit 0	Bit 1
PLC	(/)	()
PLC-2 Family	(U)	(L)

Table 4.G
Channel Select Code

Bit 17	Bit 16	Bit 15	Bit 14	Output Channel	
0	0	0	0	1771-OF Channel 1	
0	0	0	1	1771-OF Channel 2	
0	0	1	0	1771-OF Channel 3	
0	0	1	1	1771-OF Channel 4	
				1771-E4 Expander Number	**Channel Number**
0	1	0	0	1	1
0	1	0	1	1	2
0	1	1	0	1	3
0	1	1	1	1	4
1	0	0	0	2	1
1	0	0	1	2	2
1	0	1	0	2	3
1	0	1	1	2	4
1	1	0	0	3	1
1	1	0	1	3	2
1	1	1	0	3	3
1	1	1	1	3	4

On-Line Data Change

Change the value in the GET. Use an On-Line Data Change (Search 51) for both PLC and PLC-2/15 Family processors. The only difference is the message displayed on the CRT. Refer to the programming and operations manual of your processor for details.

3. Press [SEARCH] 51. The message ON-LINE DATA CHANGE appears near the bottom of the CRT screen.

4. Move the cursor to the GET.

5. Enter 000. This number will be displayed after the ON-LINE DATA CHANGE message. If any entry mistake is made, the correct value may be entered at this time.

6. Press [INSERT]. The new data is written into the GET.

Offset Adjustment: This step adjusts the offset to zero.

7. Adjust the offset pot (Figure 4.1) so that the DVM reading is within $\pm$0.1 mV of the value shown in Table 4.H for the range selected.

Gain Adjustment: This step adjusts the gain to maximum.

8. Enter 999 for BCD or 7777 for binary. Then repeat Steps 5 and 6.

9. Adjust the gain pot so that the DVM reading is within $\pm$0.10 mV of the value shown in Table 4.I for the range selected.

10. Seal both pots with sealant material.

You have finished calibrating Channel 1. Repeat Steps 2 through 10 to calibrate each of the remaining channels.

11. Press [CANCEL COMMAND] to terminate the On-Line Data Change operation.

12. Turn off industrial terminal, processor, and I/O chassis power.

13. Disconnect the DVM and load resistor.

14. Remove the analog output module from the I/O chassis.

15. Set the module function switch (SW-9) as desired for your application (Figure 4.1).

16. Replace the component-side cover.

17. Replace the analog output module in the I/O chassis.

Table 4.H
Output for All Bits OFF Code

Range	Output	Load Resistor
0 to 20mA ±20mA 4 to 20mA	0.0000V ±0.1mV -5.0000V ±0.1mV 1.0000V ±0.1mV	Across the 250 ohm Resistor
1 to 5V 0 to 5V 0 to 10 V ±10V	1.0000V ±0.1mV 0.0000V ±0.1mV 0.0000V ±0.1mV -10.0000V ±0.1mV	Across the 1.2K ohm Resistor

Table 4.I
Output for All Bits ON Code

Range	Output		Load Resistor
	BCD Mode	Binary Mode	
0 to 20 mA ±20 mA 4 to 20 mA	4.9950V ±0.1 mV 4.9800V ±0.1 mV 4.9960V ±0.1 mV	4.9990V ±0.1 mV 4.9980V ±0.1 mV 4.9990V ±0.1 mV	Across the 250 ohm Resistor
1 to 5V 0 to 5V 0 to 10V ±10V	4.9960V ±0.1 mV 4.9950V ±0.1 mV 9.9900V ±0.1 mV 9.9800V ±0.1 mV	4.9990V ±0.1 mV 4.9990V ±0.1 mV 4.9980V ±0.1 mV 9.9950V ±0.1 mV	Across the 1.2K ohm Resistor

Output Expander Module

The output expander module can be calibrated on a test bench with a ±15V DC power supply.

You will perform four steps:

- Prepare the output expander module.
- Set the reference voltage.
- Calibrate for voltage mode operation.
- Calibrate for current mode operation.

Output expander module channels are individually adjustable to any specified voltage or current range. If the range is changed, the output expander module does not have to be recalibrated.

PREPARATION

First, prepare the module by:

- Master module selection.
- Output expander module addressing.
- Power-up and reset output selection.

1. Remove the output expander module.

2. Remove the screws and component-side cover.

3. Remove all programming plugs from Channel Mode, Channel Range, Master 1/2, Expander ADDR, and Channel Return areas.

4. Insert the following plugs and these plugs only.

5. Select Master 1 (Figure 4.4) - Insert programming Plugs 9 and 27 (Table 4.J).

6. Insert Plug 80. This is Expander 1.

7. Insert plug for minimum output (Table 4.K).

8. Set the channel plugs for voltage mode and 0 to +10 volt range (Table 4.L).

9. Attach a field wiring arm.

10. Connect a 1000 ohm resistor (Table 4.A) across the selected channel field wiring arm terminals.

Figure 4.4
Programming Plug and Pot Locations (Rev. 04)

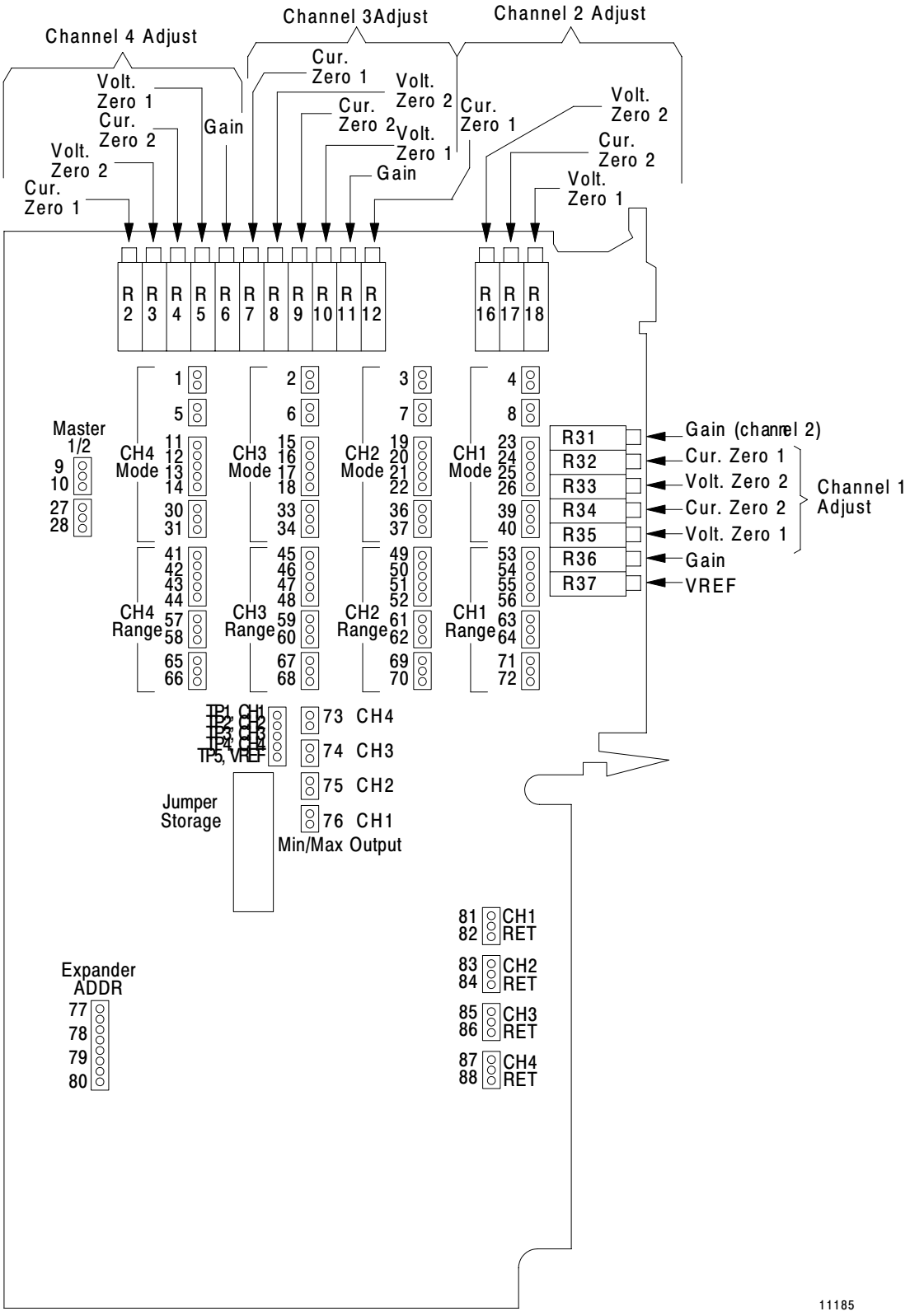
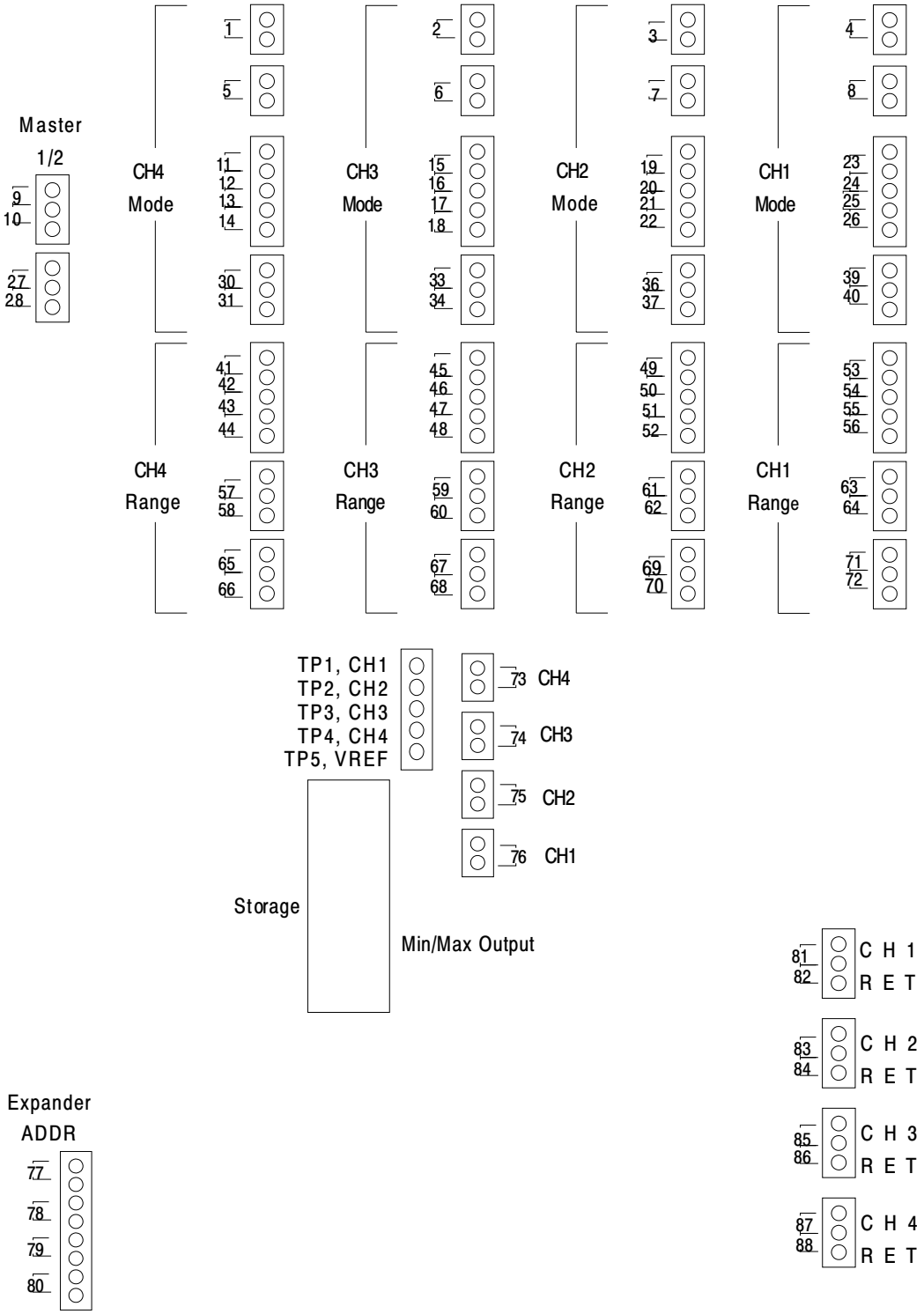


Figure 4.4
Programming Plug and Pot Locations (Rev. 04) Continued



REFERENCE VOLTAGE ADJUSTMENT

Second, adjust the reference voltage. You do not have to adjust reference voltage before each channel calibration. Once set, it need only be checked at intervals.

1. Connect the high lead of the DVM to the VREF test point.

2. Connect the ground lead of the DVM to Terminal 2 of the field wiring arm (Figure 4.5).

3. Turn on the ±15V DC power supply.

4. Adjust the reference voltage pot (R37) (Figure 4.4) for an indication of -10.0000V ±0.1mV.

Table 4.J
Master Selection (9, 10, 27, 28)

Master Selection		
	Insert	**Remove**
Master 1	9.27	10.28
Master 2	10.28	9.27

Table 4.K
Max./Min. Output Plugs

Channel Number	Plug
1	76
2	75
3	74
4	73
NOTE: Insert plugs for minimum output and remove for maximum output.	

Table 4.L
Voltage Mode and Range Selection

Channel Number	Voltage Mode	Ranges				
		0 to +5V DC	1 to +5V DC	-5 to +5V DC	0 to +10V DC	-10 to +10V DC
1	23,25,39,81	55,71	55,64,72	53,55,63	54	54, 56, 63
2	19,21,36,83	51,69	51, 62, 70	49, 51,61	50	50, 52, 61
3	15,17,33,85	47,67	47, 60, 68	45, 47, 59	46	46, 48, 59
4	11,13,30,87	43,65	43, 58, 66	41, 43, 57	42	42, 44, 57

VOLTAGE MODE ADJUSTMENT

Third, you will make two different adjustments for correct upper and lower limits:

- Voltage Zero
- Voltage Gain

Voltage Zero is measured and adjusted at two different points in the circuit. This adjustment is repeated until the two measurements are equal. Then, adjust the voltage gain.

Voltage Zero 1 Adjustment

Voltage Zero 1 is measured at a specific point within the channel or a test point.

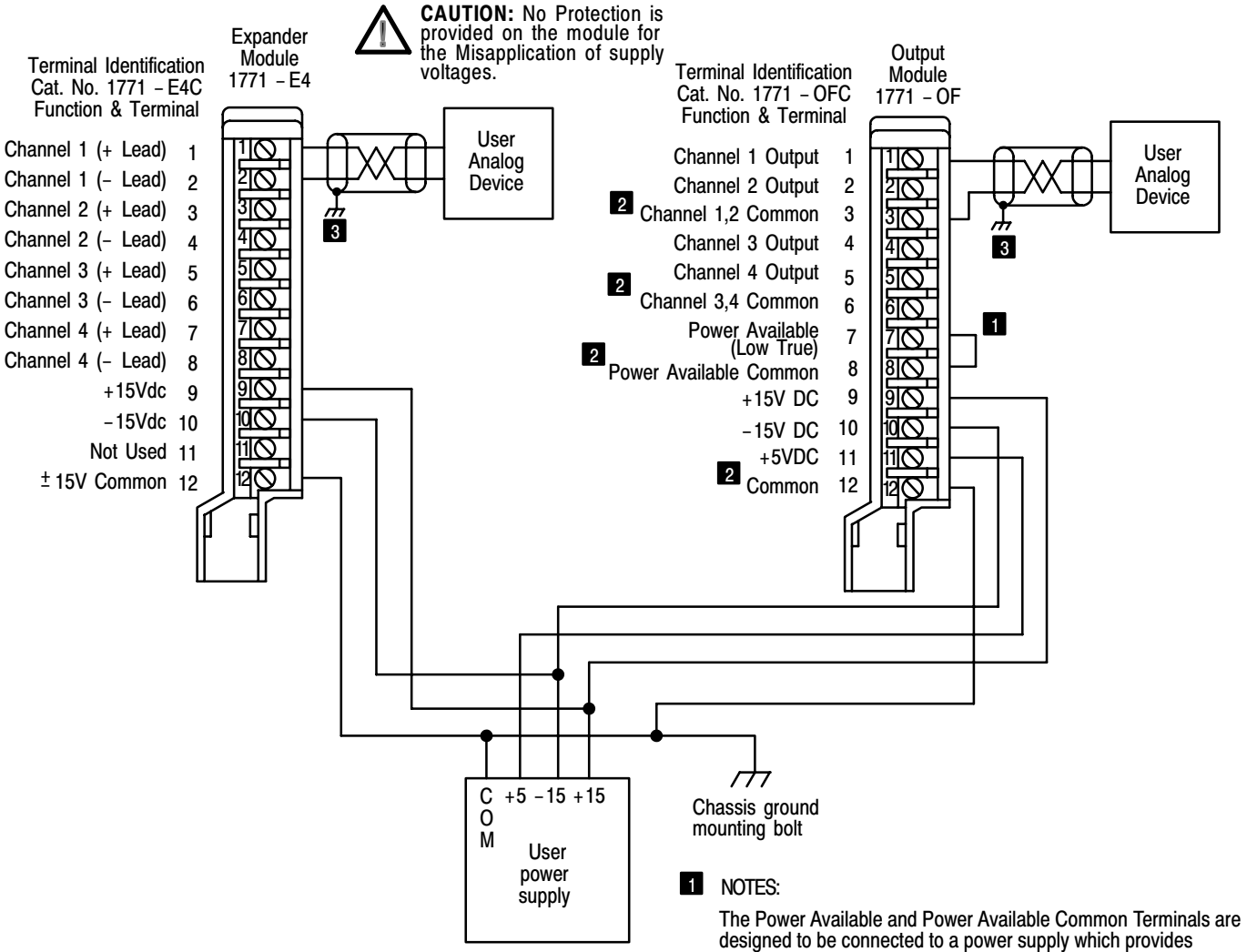
1. Connect the ground lead of the DVM to the channel's field wiring arm (-) terminal (Figure 4.5).

2. Connect the high lead to the channel's test point (Figure 4.4).

3. Set the reset/power up jumper for minimum output (Table 4.K).

4. Adjust Zero 1 (Table 4.M) until the DVM indicates 0.0000V $\pm$0.1mV.

Figure 4.5
Connection Diagram


CAUTION: No Protection is provided on the module for the Misapplication of supply voltages.
Expander Module 1771 – E4
Terminal Identification Cat. No. 1771 – E4C Function & Terminal
Channel 1 (+ Lead) 1
Channel 1 (– Lead) 2
Channel 2 (+ Lead) 3
Channel 2 (– Lead) 4
Channel 3 (+ Lead) 5
Channel 3 (– Lead) 6
Channel 4 (+ Lead) 7
Channel 4 (– Lead) 8
+15Vdc 9
–15Vdc 10
Not Used 11
± 15V Common 12
User Analog Device
Output Module 1771 – OF
Terminal Identification Cat. No. 1771 – OFC Function & Terminal
Channel 1 Output 1
Channel 2 Output 2
2 Channel 1,2 Common 3
Channel 3 Output 4
2 Channel 4 Output 5
Channel 3,4 Common 6
Power Available (Low True) 7
2 Power Available Common 8
+15V DC 9
–15V DC 10
+5VDC 11
2 Common 12
User Analog Device
C O M +5 –15 +15
User power supply
Chassis ground mounting bolt

1 NOTES:

The Power Available and Power Available Common Terminals are designed to be connected to a power supply which provides Power Available Signal. If the power supply does not provide a Power Available Signal, jumper terminals 7 and 8 together. If these terminals are not jumpered the module will not function.

2 All commons are tied together internally.

3 Ground cable to I/O chassis at module end only.

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Table 4.M
Adjustment Pot Identification

Channel	Reference	Voltage		Gain	Current	
		Zero 1	Zero 2		Zero 1	Zero 2
1	R37	R35	R33	R36	R32	R34
2		R18	R16	R31	R12	R17
3		R10	R8	R11	R7	R9
4		R5	R3	R6	R2	R4

Voltage Zero 2 Adjustment

Voltage Zero 2 is adjusted at the channel's output on the field wiring arm terminal.

5. Connect the high lead of the DVM to the channel's field wiring arm (+) terminal (Figure 4.5).

6. Adjust Zero 2 (Table 4.M) until the DVM indicates 0.0000V $\pm$0.1mV.

Voltage Gain Adjustment

Gain adjusts the upper limit of the circuit.

7. Turn off the $\pm$15 volt power supply.

8. Set the plugs for the $\pm$5 volt range. Refer to Table 4.L.

9. Set the reset/power up jumper for maximum output (Table 4.K)

10. Turn on the $\pm$15V DC power supply.

11. Adjust gain (Table 4.M) until the DVM indicates +4.9976V $\pm$0.1mV.

12. Turn off the $\pm$15V DC power supply.

CURRENT MODE ADJUSTMENT

Fourth, you will make two different adjustments for current mode:

Current Zero 1 Adjustment

Current Zero 1 is measured across a precision load resistor.

1. Set the plugs for current mode and the ±20mA range (Table 4.N).

2. Connect the 250 ohm precision load resistor (±0.025%) (Table 4.A) across the selected channel swing arm terminals.

3. Connect the DVM across the load resistor.

4. Turn on the ±15V DC power supply.

5. Adjust current Zero 1 (Table 4.M) until the DVM indicates 4.9976V ±0.1mV.

Table 4.N
Current Mode and Range Selection

Channel Number	Current Mode	Ranges			
		0 to +20 mA	-20 to +20 mA	Std. Compliance 4 to +20 mA	Add'l Compliance 4 to +20 mA
1	24, 26, 40	4, 55, 71, 81	4, 53, 55, 63, 81	4, 55, 64, 72, 81	55, 64, 72, 82
2	20, 22, 37	3, 51, 69, 83	3, 49, 51, 61, 83	3, 51, 62, 70, 83	51, 62, 70, 84
3	16, 18, 34	2, 47, 67, 85	2, 45, 47, 59, 85	2, 47, 60, 68, 85	47, 60, 68, 86
4	12, 14, 31	1, 43, 65, 87	1, 41, 43, 57, 87	1, 43, 58, 66, 87	43, 58, 66, 88

Current Zero 2 Adjustment

Place additional load resistance in series with the precision load resistor (Step 2). Current Zero 2 is measured across the precision load resistor.

6. Turn off the ±15V DC power supply.

7. Connect the (+5%) 250 ohm resistor in series with the 250 ohm precision resistor.

8. Connect the DVM across the 250 ohm precision resistor measured in Step 5 of Current Zero 1 adjustment.

9. Turn on the ±15V DC power supply.

10. Adjust current Zero 2 (Table 4.M) until the DVM indicates 4.9976V ±0.1mV.

11. Turn off the ±15V DC power supply.

12. Remove all test equipment, load resistors and the field wiring arm.

13. Set switches on the output module and plugs on the expander module for your application.

14. Install covers and tighten screws.

15. Install the output module and expander modules.

16. Attach the field wiring arm.

Chapter 5

Troubleshooting

General

This chapter is based on the diagnostic capabilities provided by the LED indicators on the front of the analog output module and output expander module, and the diagnostic bits in the status words (Table 5.A).

Table 5.A
Troubleshooting Chart

Indications		Probable Cause	Recommended Action
Block Transfer	**Single Transfer**		
Green DC ON LED on output expander module is OFF.		The DC ON indicator is illuminated if chassis power, +15V DC and 15V DC on the wiring arm are present.	Check power supplies and wiring. Correct as required.
The red FAULT LED flashes when the PC processor is in the program mode. Switch the PC processor to run mode and the LED is ON continuously.			
Bit 16 = 0	Bit 6 = 0	1. Customer supplied power not present at the field wiring arm. 2. Power available jumper missing.	Customer supplied power not present. Correct as required. Jumper Terminals 7 and 8 of the 1771–OF module.
Bit 17 = 1 One or More Bits 0 to 15 = 1	Bit 6 = 1 Bit 7 = 1 One or More Bits 0 to 2 = 1	1. Output Expander Fault a. Customer supplied power missing at the output expander. b. An output expander module has been removed or does not respond.	Check for presence of power at swing arm of the output expander. Correct as required. Remove all output expanders from the I/O chassis and cycle power. If the LED does not illuminate, the output module is good. Insert output expander modules one at a time and cycle power until the faulted module is detected. Replace as required.

Indications		Probable Cause	Recommended Action
Block Transfer	**Single Transfer**		
The red FAULT LED is on continuously with the PC processor in the program and run modes.			
Bit 17 = 1 One or More Bits 0 to 15 = 1	Bit 6 = 1 Bit 7 = 1 One or More Bits 0 to 2 = 1	1. Output expander address or master programming plugs have been mis programmed.	Output expanders must be numbered consecutively. Reprogram as required.
Block transfers are not being performed.	Bit 7 = 1	2. Output module has failed self–diagnostic tests.	Cycle power to attempt to clear fault. Replace faulty output module if necessary.
Bit 17 = 1 One or More Bits 0 to 15 = 1	Bit 6 = 1 Bit 7 = 1 One or More Bits 0 to 2 = 1	3. The output module is programmed as Master 2 without a Master 1 in the I/O chassis.	When only one master is in the I/O chassis, it must be programmed as Master 1. Output expanders must be programmed to respond to Master 1 or Master 2.
Output voltage not responding as programmed.		1. Module not programmed correctly.	
Bit 17 = 0 Block Transfer Not Performed	Bit 5 = 0	a. <u>Block Transfe</u>r Block transfer length is greater than the number of channels available for update. <u>Single Transfer</u> Invalid channel requested for update.	The module will only allow a write block transfer less than or equal to the number of channels available in the system. If block transfer is programmed for the default case (i.e., Block Length = 0), the module will allow a write block transfer corresponding to the maximum number of channels in the system and a read block transfer of one word.
Bit 17 = 0 Block Transfer Not Performed	Not Applicable	b. Block transfer instruction misprogrammed.	Refer to Chapter 3, Section 3 .1 on block transfer programming.
No indication	No Indication	c. An invalid BCD number was sent when the module is programmed for BCD.	When configured for BCD, the module will ignore invalid BCD numbers (i.e., 95A) and the output will remain at the last valid number.
No Indication	No Indication	2. Two output expander modules are programmed for the same address.	Check the programming plug selectable address of the output expanders. The analog output module cannot detect when two or more output expanders are programmed for the same address.

Appendix A

Block Transfer Program

General

This appendix provides a sample block transfer program for programming a PLC-2/30 programmable controller to access an analog output module that has three output expander modules. The only change to the sample program required to address the full 14 output expanders (60 output channels) would be the addition of display rungs if they were required.

Overview

Bi-directional block transfer is the sequential performance of read and write operations. The program shown in Figure A.1 and described in Table A.A directs the processor to perform bi-directional block transfer.

Two rungs of user program are required--one containing the block transfer read instruction, the other containing the block transfer write instruction. When both instructions are given the same module address, the pair are considered as bi-directional block transfer instructions.

The operation of bi-directional block transfer is similar to that described in Chapter 3 - Block Transfer Interface. Additional consideration for bi-directional operation will be described using an example read and write instruction with equal block lengths having the following parameters:

WRITE Instruction	
Data Address	030
Module Address	200
Block Length	00
File	200-277
READ Instruction	
Data Address	031
Module Address	200
Block Length	00
File	300-377

For write and read instructions, Block Length 00 sets aside 64 words. However, the processor writes only up to 60 words maximum. It writes only as many words as the system has channels. The processor reads only one word at a time. The file should contain the number of words which correspond to the total number of output channels based on the number of analog output modules and output expander modules.

Figure A.1
Application Program - Block Transfer

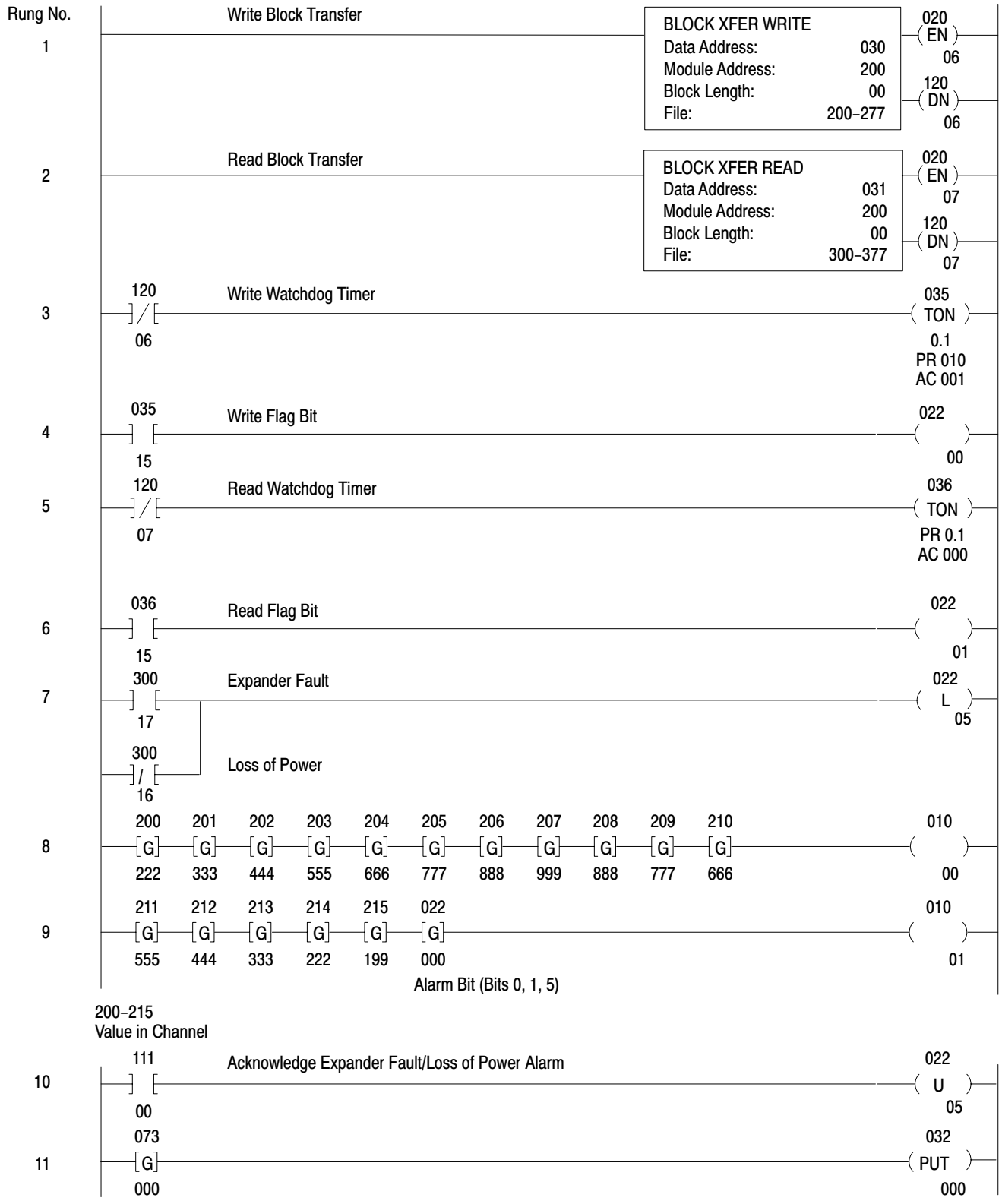


Table A.A
Program Description, Block Transfer

Rung	Action
1	**Write Block Transfer 030** This is an unconditional write block transfer. The module is located in Rack 2, Module Group 0 and Slot 0. Block Length 00 is the default value and causes up to 60 words to be written to the module. Temporary analog values to be stored in Words 200-277. Bit 020/06 is the enable bit and 120/06 is the done bit .
2	**Read Block Transfer 031** This is an unconditional read block transfer. The module is located in Rack 2 Module Group 0 and Slot 0. Block Length 00 is the default value and only one word will be read from the module. It will be the first word in File 300-377. Bit 020/07 is the enable bit and 120/07 is the done bit.
3	**Write Watchdog Timer 035** When the write block transfer done bit is not set (120/06 set to 0), Timer 035 starts. If the done bit is not set to 1 within 1 second, Timer 035 will time out (setting Bit 035/15 to 1). If the done bit is set to 1 within 1 second, the timer is reset in this example, the value of 1 second was chosen. The preset value will be different depending upon the application.
4	**Write Flag Bit 02200** When the write watchdog timer (035) times out, Bit 035/15 is set to 1 and Bit 022/00 is energized. This bit indicates that the write block transfer was not completed in 1 second.
5	**Read Watchdog Timer 036** When the read block transfer done bit is not set (120/07 set to 0), Timer 036 starts. If the done bit is not set to 1 within 1 second, Timer 036 will time out (setting Bit 036/15 to 1). If the done bit is set to 1 within 1 second, the timer is reset. In this example, the value of 1 second was chosen. The preset value will be different depending upon the application.
6	**Read Flag Bit 02201** When the read watchdog timer (036) times out, Bit 036/15 is set 1 and Bit 022/01 is energized. This bit indicates that the read block transfer was not completed in 1 second.
7	**Expander Fault Bit 02205** If there is an expander fault (Bit 300/17 is ON) or power is not available (Bit 300/16 is OFF), Bit 022/05 is latched ON.
8,9	**Display Rungs** These rungs have no effect on program operation. they provide a means of displaying values (GET 200 through 215), and turn on alarm bits (GET 022 contains a bit 022/00; write flag bit 022/01; read flag bit and the hardware fault bit 022/05.) These rungs are not essential to the program and are provided for display purpose. Another technique to display the analog output values would be to place the cursor on the write block transfer instruction and use the “DISPLAY” capabilities of the industrial terminal.
10	**Acknowledge Alarm** Resets Alarm Bit 022/05 after an expander fault or power failure has been detected.
11	Boundary between block transfer data addresses and T/C addresses.

Appendix **B**

Single Transfer Program

General

This appendix has two sample single transfer programs and program descriptions. The same program may be entered in a PLC or PLC-2 family processor. The only difference between the two programs will be the address and types of output instructions. The interpretation of these instructions is shown in Table B.A. These programs show how to access:

- One (1) channel for test purposes.
- Sixteen (16) channels include one analog output module and three output expander modules.

The output channel is selected by setting Channel Select Bits 14-17 (Table B.B) in the output image table word which corresponds to the analog output module's I/O chassis location. The bits are actually set in the intermediate word. The interpretation of these bits is shown in Table B.A.

Data is transferred from the intermediate word address corresponding to each channel (GET) to the output image table word address corresponding to the analog output module (PUT). Once a value is entered into a channel, the value is maintained there until a new value is entered for that channel.

Table B.A
Output Instructions

Processor	Bit 0	Bit 1
PLC	(/)	( )
PLC-2 Family	(U)	(L)

Table B.B
Channel Select Code

Bit 17	Bit 16	Bit 15	Bit 14	Output Channel	
0	0	0	0	1771-OF Channel 1	
0	0	0	1	1771-OF Channel 2	
0	0	1	0	1771-OF Channel 3	
0	0	1	1	1771-OF Channel 4	
				1771-E4 Expander Number	**Channel Number**
0	1	0	0	1	1
0	1	0	1	1	2
0	1	1	0	1	3
0	1	1	1	1	4
1	0	0	0	2	1
1	0	0	1	2	2
1	0	1	0	2	3
1	0	1	1	2	4
1	1	0	0	3	1
1	1	0	1	3	2
1	1	1	0	3	3
1	1	1	1	3	4

Sample Programs

There are two sample programs described below. The first program is a single channel program. This program can be used to calibrate the analog output module. The second program is a 16-channel program. This is a general program which shows the required programming for one analog output module and three associated output expander modules.

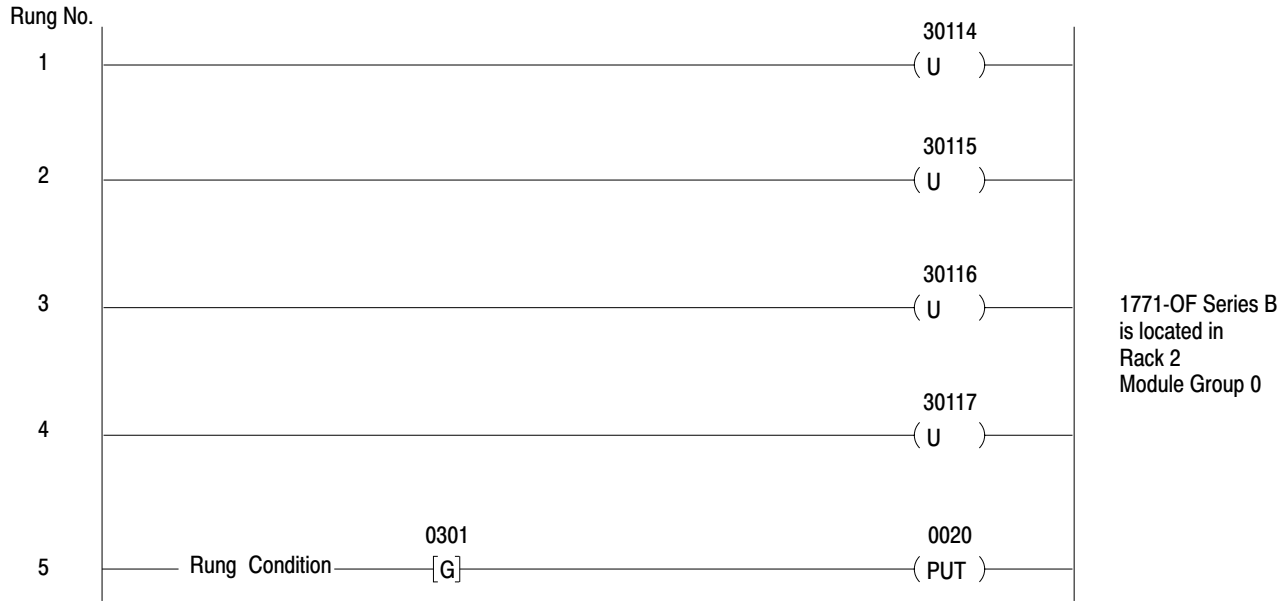
One Channel Test Program

Table B.C describes each rung in the test program illustrated in Figure B.1.

Table B.C
Test Program Description

Rung	Action
1, 2, 3, 4	Bits 14,15,16 and 17 of Intermediate Word 301 are all unlatch. Unlatch is interpreted as a zero, latch is interpreted as a one. Since all four rungs are unlatched or zeros, Channel 1 is selected (Table B.A).
5	When rung conditions are met, the output signal value in GET 0301 is transferred from Intermediate Word 0301 and put in Address 0020.

Figure B.1
One-Channel Program Test



Channel 1 value is stored in Word 0301.
Channel Select Bits 14, 15, 16, 17 are set to 0 to Select Channel 1.
Rung 5 enabled to transfer Channel 1 to 1771-OF Series B.

Complete 16-Channel Program

Table B.D describes each rung in the complete program of Figure B.2.

Table B.D
Program Description, Single Transfer, with Three Expanders

Rung	Action
1,	**Free-Running Timer 070** The Timed-Bit 070/15 is turned on turning on Timer 070. The timer has a preset of 16. When the accumulated value equals the preset, the timed-bit turns off resetting Timer 070.
2, 3, 4, 5	**Channel Select Rungs Channel 1** Bits 14, 15, 16, and 17 of Intermediate Word 301 are all EXAMINE OFF. EXAMINE ON is interpreted as a one, EXAMINE OFF is interpreted as a zero. Therefore, Channel 1 has been selected (Table B.A). **NOTE:** Rungs 2 through 65 operate in groups of four, i.e., Rungs 6, 7, 8, 9 select Channel 2. Rungs 10, 11, 12, 13 select Channel 3, etc. Since these rungs are identical in function to Rungs 2, 3, 4, 5, in this table, they have been omitted for clarity.
66	**Channel 1 Transfer 0301** GET 0070 represents the accumulated value at any instant. When the value of GET 0070 is the same as EQU 071(1), the value in GET 0301 is transferred from Intermediate Word 0301 and PUT in the address which is the same as the Output Module Location 0020.
67	When GET 0070 (the accumulated timer value) is equal to 2 (the value in EQU 072), the value in Intermediate Word 0302 is transferred to PUT 0020 which is the module location. **NOTE:** Rungs 68 through 81 transfer Channels 3 through 16, respectively. The transfer is based on the current accumulated timer value. Rungs 67 through 80 are similar to Rung 66 and in this table are omitted for clarity.
82, 83	**Display Rungs** These rungs have no effect on program operation. they provide a means of displaying values in Words 0301 through 0320. GET 0120 is the value in the input image table word read by the processor. Its sole function is to provide diagnostic bits for Rung 84.
84	**Diagnostic Rung** The Fault Bit 120/07, Power Available Bit 120/06, and Valid Channel Address Bit 120/05 are displayed with this rung. Each individually is a diagnostic bit. If all bits indicate faults, Bit 067/00 is latched on..

Figure B.2
Application Program - Single Transfer with Three Expanders

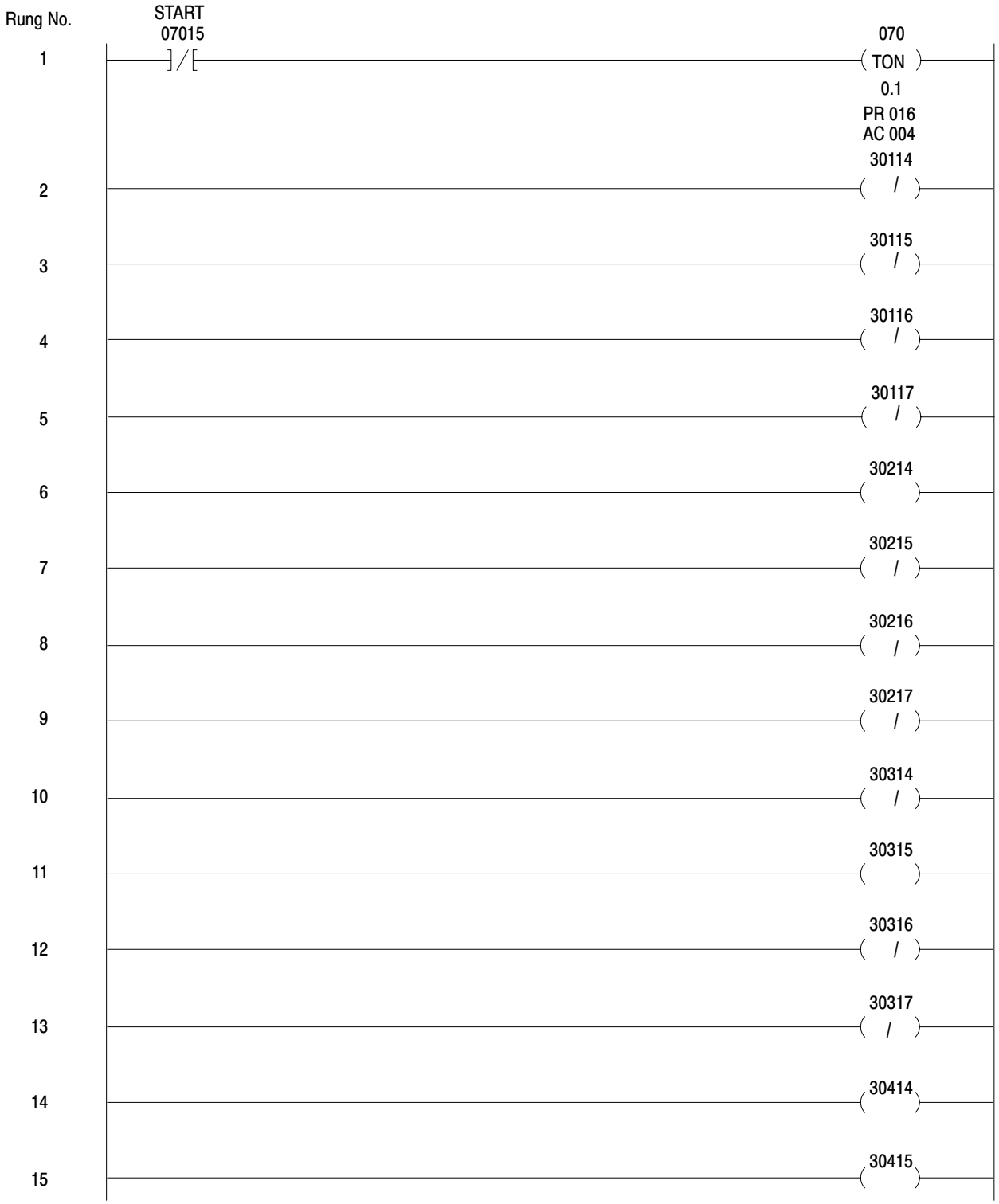


Figure B.2
Application Program - Single Transfer with Three Expanders Cont'd

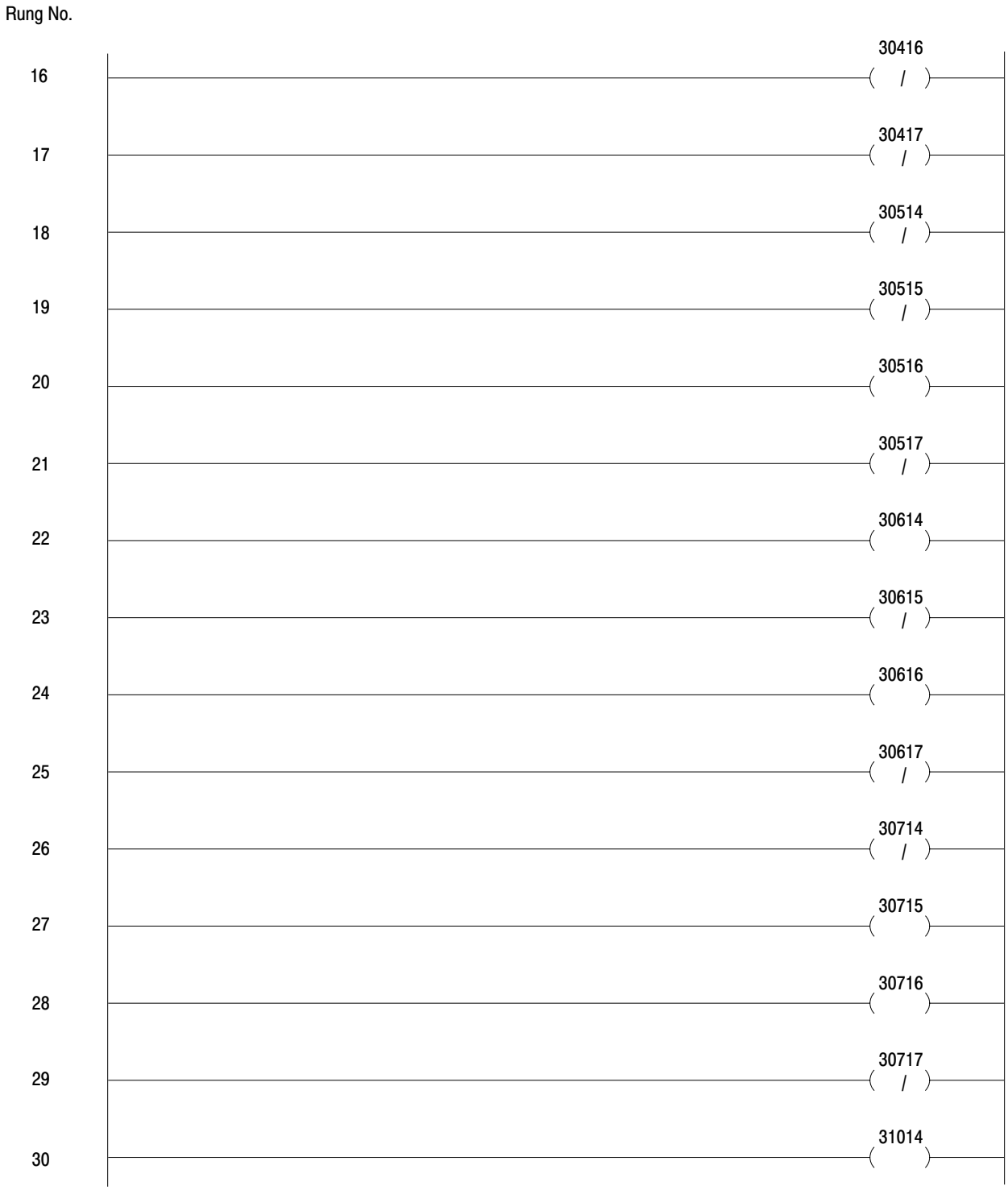


Figure B.2
Application Program - Single Transfer with Three Expanders Cont'd

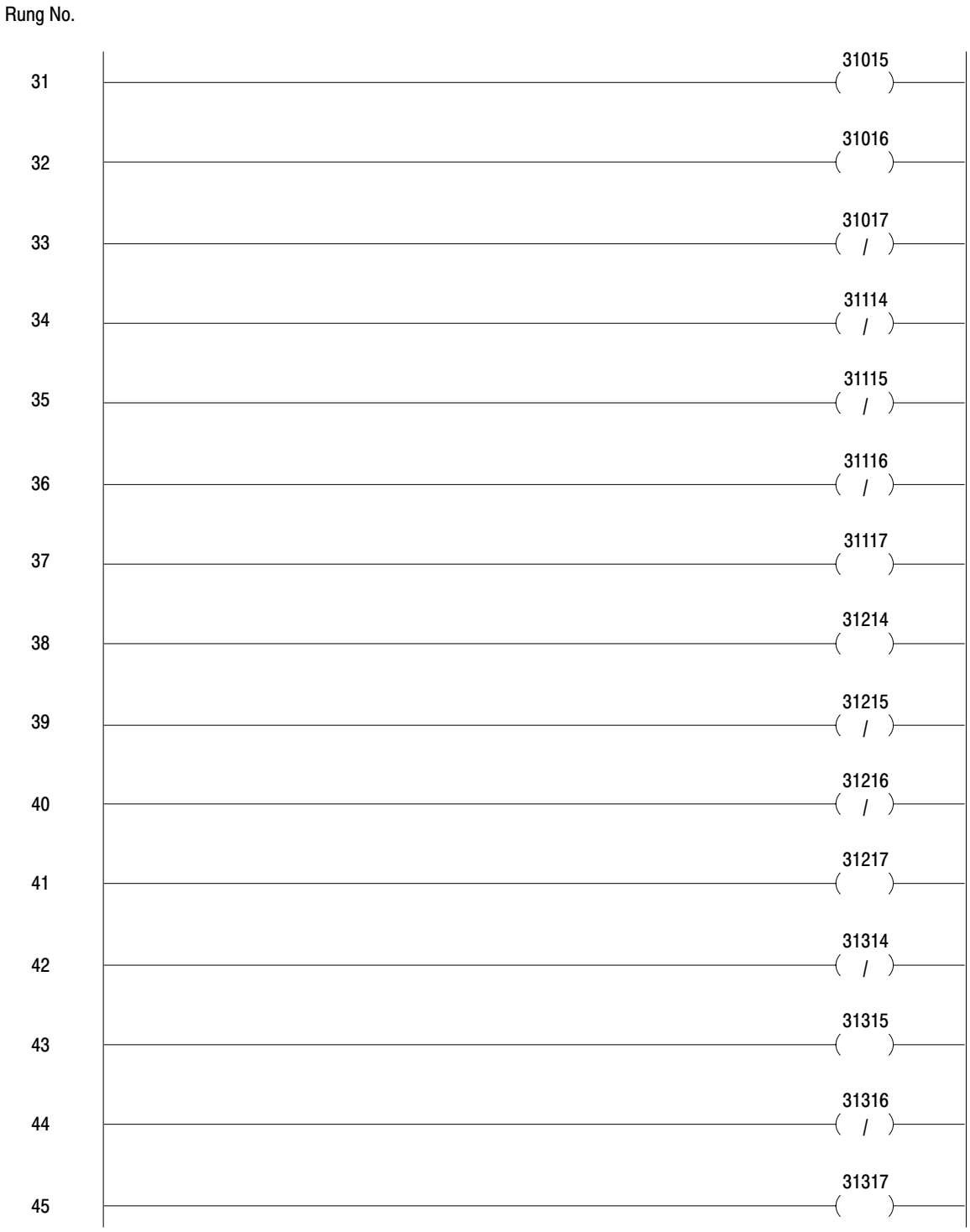


Figure B.2
Application Program - Single Transfer with Three Expanders Cont'd

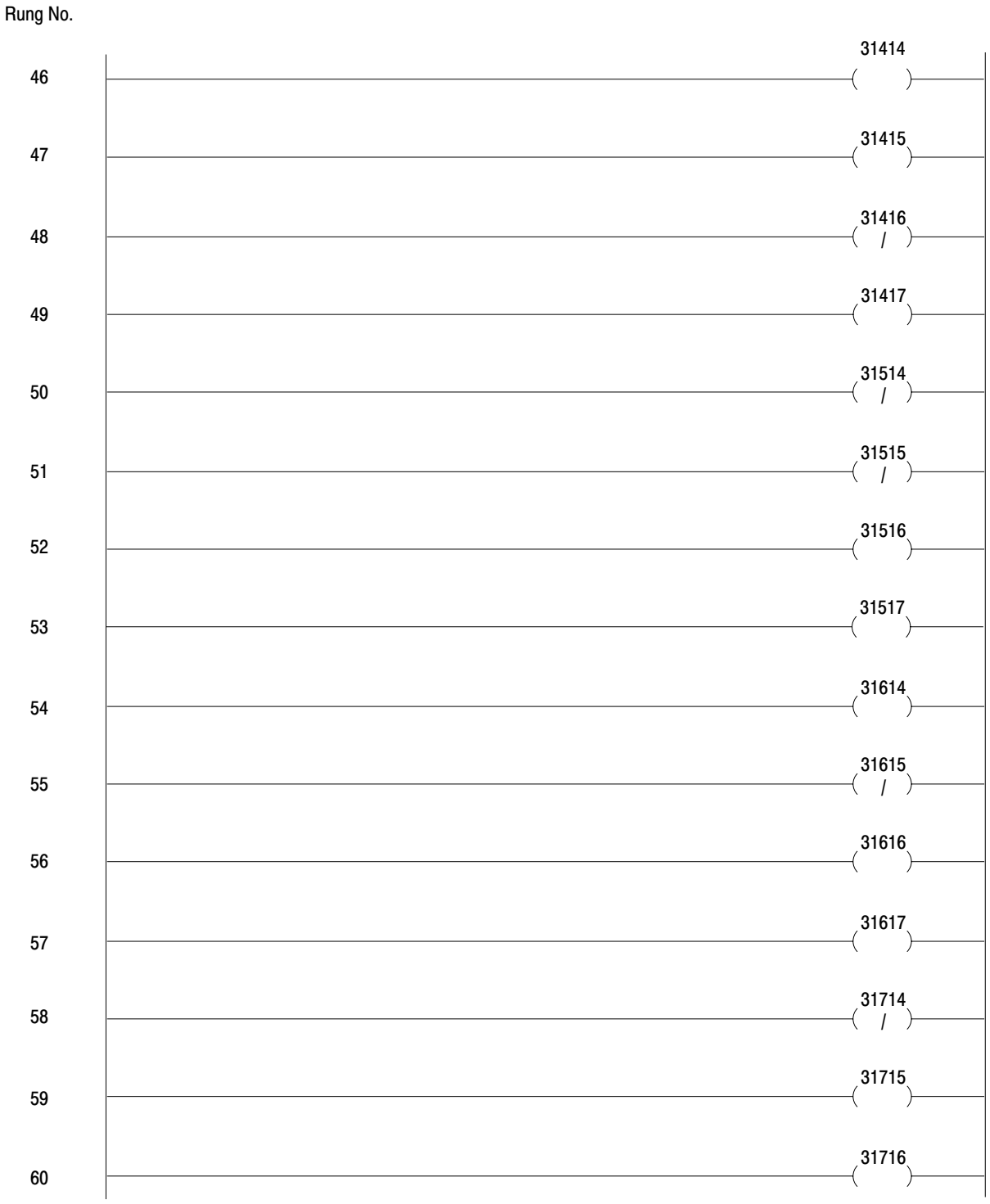


Figure B.2
Application Program - Single Transfer with Three Expanders Cont'd

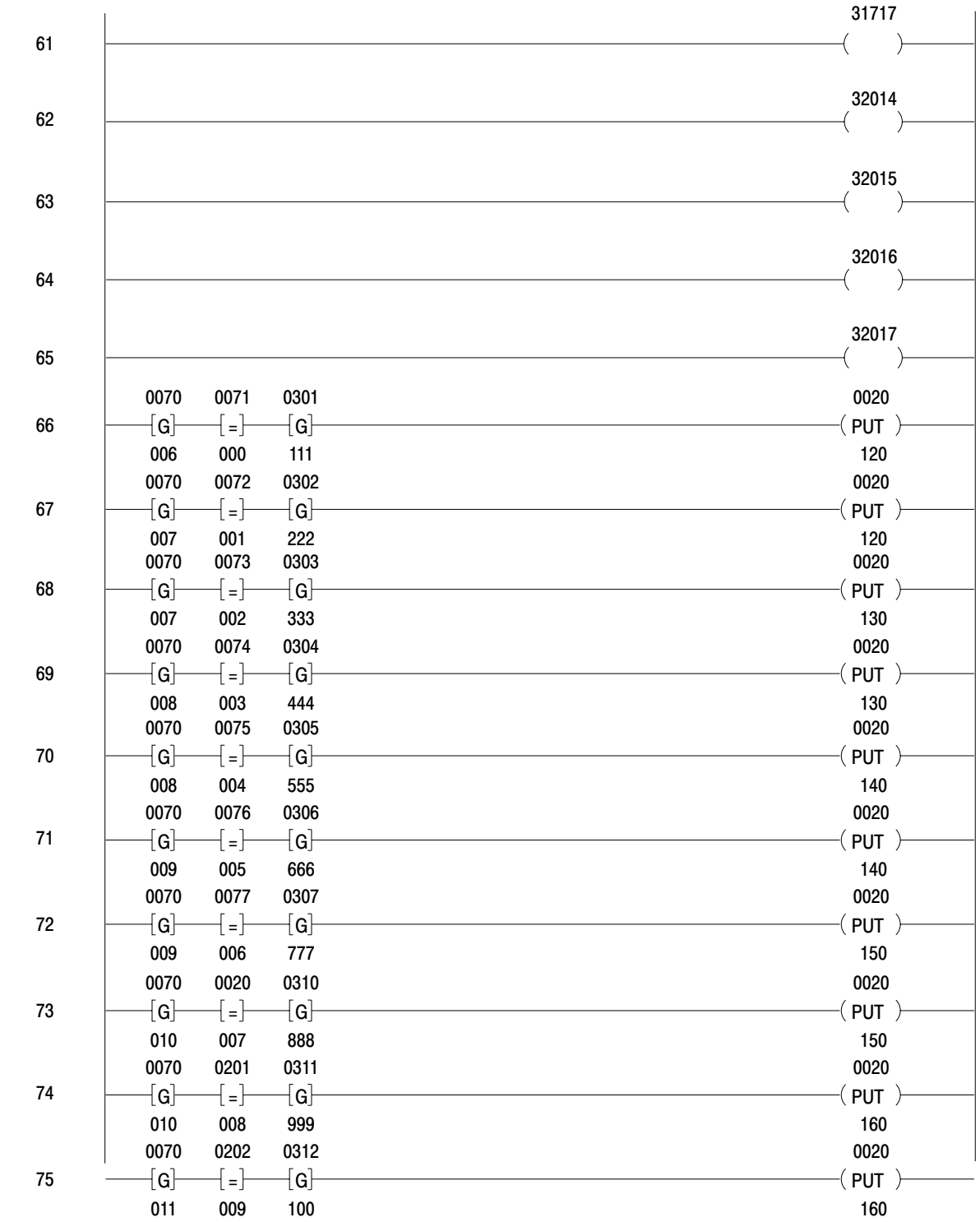
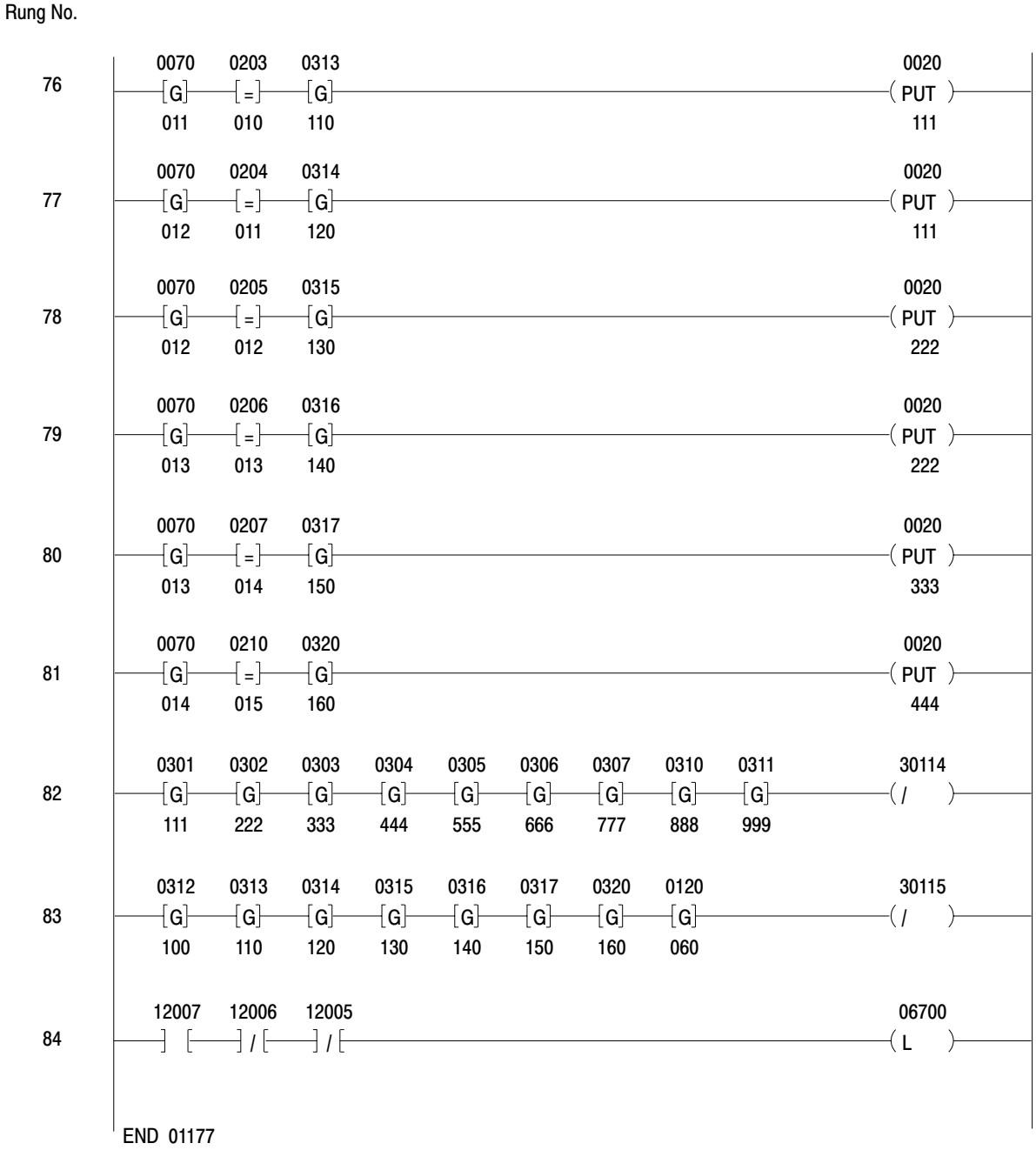


Figure B.2
Application Program - Single Transfer with Three Expanders Cont'd



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